INSECT AND FUNGUS PESTS

OF THE

ORCHARD AND FARM

(THIRD EDITION)

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BY

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PREFACE TO THE THIRD EDITION.

In the preceding editions pests of the potato and other vegetables were hardly mentioned; in the present one this has been remedied to a certain extent, although some of their more obscure diseases and insects have been passed over. Very few also of the pests of wheat and other cereals have been noticed. But the principal aims of this work are to enable orchardists to readily identify the more common pests with which they have to deal, and to bring together in a handy form the various remedies which have been found useful against such pests. Should the work extend to further editions it is hoped to have a figure of each pest dealt with, but at present such are not available.

THE ILLUSTRATIONS.

The figure on page 20 is from the Western Australian Department of Agriculture. The figure on page 135, and the lower one on page 132, are from the United States Department of Agriculture. Twenty-seven are fresh blocks from the writer's drawings. All the others have been acknowledged in the second edition, or beneath the blocks themselves.

COUNCIL OF AGRICULTURE, TASMANIA.

INSECT AND FUNGUS PESTS

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ORCHARD AND FARM.

By Arthur M. Lea, F.E.S., &c., Government Entomologist.

THE pests which attack plants are numbered by thousands, and many are practically distributed over the habitable parts of the world; others again are extremely local. Some are so severe that during certain seasons they practically eat everything before them; numerous accounts, for instance, have appeared of locusts or grasshoppers causing famines. Other pests confine their attacks to a few plants only, such as the codlin moth to pip fruits and the potato moth to solanaceous plants. Some again attack only one kind of plant. Many insects in a state of nature live at the expense of our native plants, but have adapted themselves to altered conditions, and now live at the expense of cultivated plants. A few species, also, as with many birds, are injurious during portions of their lives, but useful during others.

The parts which many insects play in the economy of Nature, though apparently at first sight injurious, are actually useful, and it is only when they overstep their natural spheres of action or become introduced into new surroundings that they really become injurious. If trees when they fell had no other agencies at work upon them than the rain and seasons, they would cumber the ground and prevent other trees taking their places for long periods. Let us see therefore what takes place. A tree is blown down by a gale of wind; almost as soon as it is down boring insects resort to it to lay their eggs, the larvæ hatch out and bore their way into the heart of the tree, thus allowing the rain to penetrate and soften it; then other insects appear, which feed upon the partially-softened wood, and still further admit the damp so essential to decay. Termites or white ants attack it, so that in a comparatively short time the tree disappears, having returned to and enriched the soil.

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In open country where insects are less numerous this process is much more gradual than in heavily timbered country where they abound, and especially in the tropics.

Insects also serve as a check to the undue multiplication of various plants, and it is only when those plants are cultivated on a large scale, or when (principally by man's agency) the checks to the insects themselves are partially withdrawn, that it becomes possible for them to increase to such an enormous extent as to become pestiferous. The powers of increase of almost all insects are so enormous that were the checks to the multiplication of any one species withdrawn, that species would increase so rapidly as to almost or quite exterminate the plant or plants upon which it fed, until starvation again reduced its numbers.

Many insects are highly destructive to cultivated plants, but it should not be forgotten that this is really due to man upsetting the balance of Nature. Under normal conditions probably no insect or any other animal would continue unduly destructive for extended periods of time; there would of course be occasional outbreaks, but these would be short-lived. Man, however, so alters the face of the country he lives in that many insects are completely exterminated and others get the chance to increase enormously. Birds also, which naturally keep many kinds of insects in check, are driven away from cultivation, even when they are not ruthlessly shot off by the small boy and by those who should know better.

Owing largely to modern facilities for transport some insects have become established in countries far from their native home. In their normal surroundings many causes combine to keep them in check, but when in new surroundings, where these checks are absent, they have increased so enormously as to become very serious pests. Several instances of this may be given:– The codlin moth is a native of Europe, but since its introduction to Australasia and America has become so serious that, if it were not continually fought against, it would completely destroy the apple-growing industry. The *Phylloxera* (an aphis of the grape-vine) is a native of America, where it is not regarded as a serious pest, but after its introduction to Europe it completely destroyed thousands of acres of the best vineyards of France and Spain. The cottony-cushion scale (*Icerya purchasi*) is a native of Australia and Tasmania, where it never does any serious harm, but when introduced to California it at one time threatened to destroy the orange industry. The San Jose scale (supposed to be a native of China or Japan) has done enormous damage in the United States. Fruit flies have done enormous damage in Australia since their introduction. The common cabbage butterfly of Europe at one time threatened to prevent the cultivation of the cabbage and other cruciferous plants in America. Many other cases could be cited. In some of these the pests have been brought under control by means of their natural parasites, but others are still serious. On looking at the list of pests occurring in Tasmania, it will be noticed that nearly all of our more serious pests have been introduced.

From their habits and methods of attack, insects, &c., may be divided into groups, as follows:—

1. Insects provided with jaws, and exposed from first hatching out to becoming full fed.

Examples: Looper caterpillars, cabbage moth, pear or cherry slug.
Remedies: Sprays to kill by contact or by internal poisoning.

2. *Insects provided with jaws, and exposed during a short period of life only.*
   Examples: Codlin moth, light-brown apple moth.
   Remedies: Sprays to kill by internal poisoning; picking and bandaging.
3. Insects which bore into wood, either above or below ground.
   Examples: Cherry-borers, Longicorn larvæ.
   Remedies: As a rule sprays are useless against such pests, which require to be located before being destroyed.
4. Insects which suck up their nourishment and become more or less permanently fastened to their food plants.
   Examples: Scale insects, aphides.
   Remedies: Sprays to kill by contact or suffocation; poisonous fumes. Certain manures can also sometimes be used to render the sap distasteful or poisonous.
5. Insects which suck up nourishment, but which can fly or walk.
   Examples: Rutherglen and soldier bugs, plant-bugs generally.
   Remedies: As a rule only contact sprays can be used, and very few of these are of any use.
6. Maggots which live within fruits and vegetables or between the skins of leaves.
   Examples: Queensland and Mediterranean fruit flies, cinneraria fly.
   Remedies: Picking affected fruits or leaves and burning or boiling them.
7. Insects which feed on bark or young buds.
   Examples: Weevils generally.
   Remedies: As a rule these have to be hand-picked or jarred into sheets or umbrellas; but, where very numerous, they can be poisoned with arsenical sprays.
8. Animal parasites.
   Examples: Sheep-tick, cattle-tick, lice, and fleas.
   Remedies: Dipping and special methods.
9. Mites.
   Examples: Pear-mite, red spider.
   Remedies: Contact sprays or fumigation.

It is evident, therefore, that where we have so many classes of insects to contend against, no one remedy can be sufficient, despite the many remedies claimed to have the power to destroy all sorts of insects and fungi.

LEPIDOPTERA OR MOTHS.

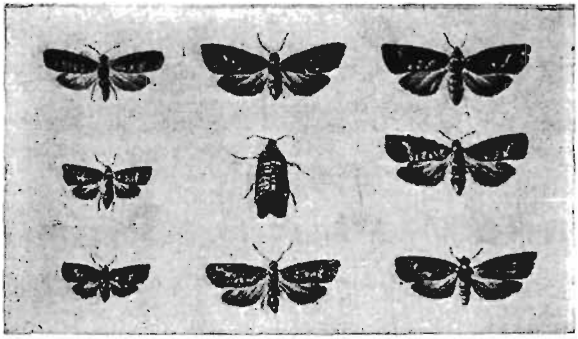
Codlin Moth.

Against this, certainly the most serious insect pest in Tasmania, there are several ways of fighting.

Where the orchard is small and isolated, probably the best way of all is to destroy the entire crop of fruit for a season.

This should be done in January or late in December. Time should be allowed for the moths to lay their eggs, and for the larvæ to hatch out, but not mature (if any are allowed to mature, it will become necessary to pick the crop the ensuing season). The reason for this is that the moth, although usually a stay-at-home insect, can, if pressed for it (such as the total absence of fruit upon which to lay its eggs), fly for a long distance. Should the apples and other fruits, therefore, be picked as soon as they are formed, the moths, on coming out to lay their eggs, and not finding any fruits on which to lay them, will fly off to the nearest orchards, although these may be miles away; for it must be remembered that insects are provided with an instinct which enables them to find their food-plants wherever these may be.

The moth lays its eggs usually (but not always) on the side of the apple. They are occasionally laid on leaves near a bunch of apples. In Tasmania (where the moth is single-brooded) they are laid from early in November to early in March, and as the eggs last for but a few days, it can be seen that any remedy (however effective it might be against any eggs touched by it) against them would have to be applied



Varieties of the Codlin Moth (after Slingerland).

so frequently as to render it too expensive for general use. The eggs are very thin, and are most difficult to detect; on the grubs leaving them, however, they appear like thin round flakes of mica, and are more easily found, up to about three days after the grub has hatched, but they then fall or are blown off. Before the young grub hatches out of the egg it can be seen as a reddish circular streak inside.

The young grub, on hatching out, does not go into the apple at once, and from beneath its egg-shell, as has been supposed by some (nor does it eat the shell, as the larvæ of so many insects do), but usually wanders about, feeding on the top of the apple or in the eye: here (in young fruit especially) there is a certain amount of short glassy interlacing threads (looking like fine white down to the naked eye), which the youngster appears to be fond of, and which serves to entangle any poison which may be sprayed upon the fruit. Many believe that the grubs enter the apples at the exact spot where the eggs are laid, but examination of the skin in the vicinity of the empty egg-shells disproves this idea.

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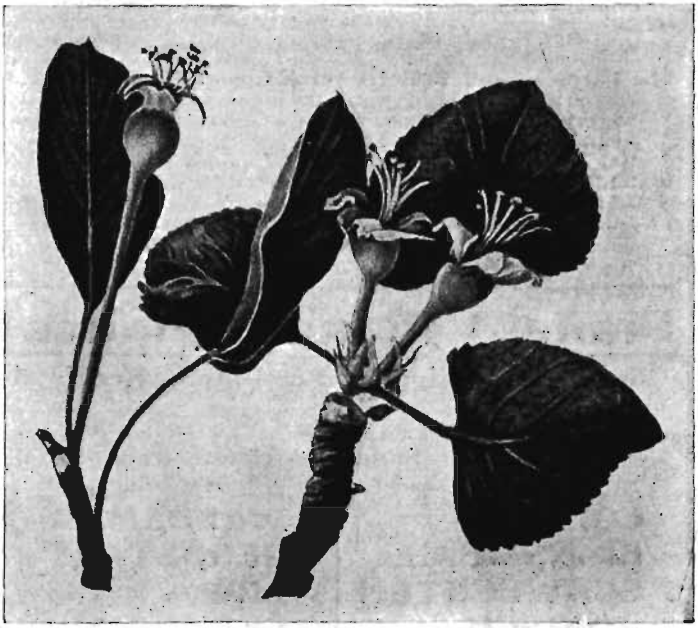
It is here necessary to notice a peculiarity in the growth of the apple. As soon as the petals of the flowers have fallen, it can be noticed that on the top of the young apple five triangular lobes project in a circle round a small hollow or cup (often called the eye); later on, the lobes close over this hollow. It was found in the United States that if poison could be lodged in these cups just before the lobes closed over, it would be protected against the weather, and as a very large percentage of grubs go in at the eye, nearly all of these would be destroyed. Statements have been frequently made in the United States that one spraying at this particular time was worth many later ones, and doubtless this is the case where the egg-laying is at all regular. In Tasmania, however, this



Apples and Pear just after Petals have fallen (after Slingerland).

is not the case, so that several sprayings are necessary during the season; nevertheless, the first, and undoubtedly the most important time to spray in Tasmania is soon after the petals have fallen, and before the lobes have closed over. Should heavy rain fall soon after the spraying it will be necessary to at once repeat it. Light rain, however, appears to make very little difference, as the particles of Paris green are retained by the fluffy material about the eye. On the apples growing larger this fluffy material (except a small part about the eye itself) is lost. From our own experience we imagine

that three sprayings should be ample—once before the lobes have closed (which should be late in October or early in November), once in December, and once in January.

The statement that the majority of codlin grubs go in at the eye has been frequently challenged, but is, nevertheless, quite correct. An apple with a large hole in its side is a much more conspicuous object on a tree than one with a few grains like dust about the eye, and, consequently, many of the latter are overlooked. In many instances, on examining an apple with a large side-hole, it will be found that the grub had originally gone in at the eye (especially when the fruit has been struck early in the season), fed around, and on the core of the growing apple (the original hole of entrance having closed up meanwhile, but the channel of the grub being marked by a dark streak) and, on becoming fairly large, made a passage to the side to void its excrement, and its exit hole has been erroneously judged to be its entrance point.

Many poisons have been used against the grubs, but the only ones which have been regarded as of any real benefit are those having arsenic in some form or other as their principal ingredient. The principal ones are:—

Paris green.
London purple.
Arsenic and soda.
Arsenic and lime.
Arseniate of lead.

Particulars of these are given at the end.

No matter how carefully nor how frequently spraying is done, however, a number of grubs are certain to escape destruction, and to enter into the fruit; and, of course, where no spraying is done, nearly all will enter. It is, therefore, necessary to pick the grubby apples, and to bandage the trees. Picking should be done very carefully, and every apple should be examined, especially about the eye, for very often the only sign of the presence of a grub is a small quantity of dust-like grains or of slimy liquid oozing from the eye.

The codlin grub will frequently enter where two apples touch, or where an apple touches a twig or a leaf. Sometimes the opening into the apple will be entirely concealed by a leaf being cemented to it with silk. In many apples, on examination, a codlin grub can be found with apparently no external mark of its presence. Sometimes a small brown speck about the eye is the only sign.

Where spraying is done for the codlin moth apples are frequently seen that have small reddish spots; these are often caused by the young and poisoned codlin grubs having had time to enter the apples before being killed by the poison. On closely examining these holes minute dead grubs may sometimes be found, although these soon rot away.

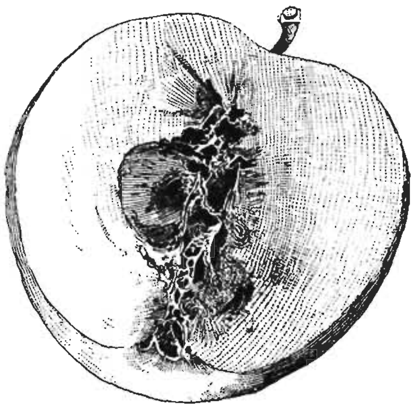
Usually, after being struck by a poisoned grub, a frothy substance rises from the hole, and afterwards settles down as a small whitish patch. Where a healthy grub strikes the apple usually no change takes place.

The grubs have a ripening effect on the fruit, and, on becoming full-fed, have a tendency to cause them to fall; usually the shock of the fall will cause the grubs to leave the

fruit, but not always, so that it is necessary to pick up and destroy all those that fall to the ground.

On becoming full-fed the grub seeks for some place in which to spend the winter; this, in a state of nature is in the rough bark of the trunk and larger limbs. It is owing to this habit that another method (bandaging) can be used against it, for the grubs, although appearing to prefer rough bark, when rough bark and bandages are present on the same tree, will often go into the bandages even on such trees, and when the trees are naturally smooth-barked or have been scraped smooth, nearly all the grubs will go into the bandages.

On removing the bandages, it is necessary to keep a sharp look-out for any grubs which may fall to the ground, as many will do; then the trunk of the tree beneath the bandage should be very carefully examined, and gone over with a pointed instrument, for the cocoon formed by the grub is often so like



Section of Grubby Apple.

the bark that it is difficult to detect it. The bandages themselves should be crushed between rollers, or boiled, to destroy any grubs present—simply searching for the grubs, and replacing the bandages when all seen are destroyed, will result in the escape of many grubs; for, no matter what the bandaging material may be, the grubs are such adepts at concealment that many can never be found by the eye—but boiling water will find the lot.

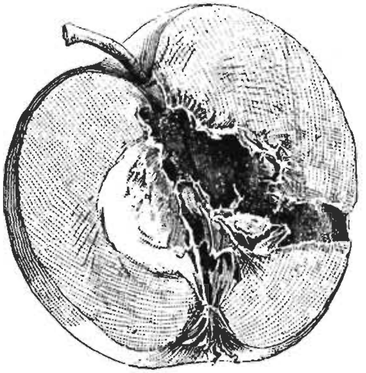
The bandaging material most commonly used is old sacks or burlap, and is undoubtedly very useful, but, where it can be obtained cheaply, old clothing (especially when containing wool) is better; the grubs seem more contented in it, and are not so liable to change their position.

Where the bandaging material is stout the grubs are much less liable to shift after once settling down, and they are more likely to go into the bandage itself than into the bark beneath it, so that it is false economy to use small and flimsy bandages.

A plan largely adopted in Tasmania is, instead of the bandage to place a bundle of sacking in the fork of the tree; but this, though saving considerable time, is far inferior to the bandages as a method of trapping the grubs.

A trap found useful is to nail two shingles together, with a piece of sacking between them, and throw these down near the trees; *many grubs are attracted by them which would not* go to the bandages, but used alone they are very inferior to the bandages.

It has frequently been noticed that trees nearest the apple-house are much more affected than those at a distance from it, *more especially when it has been the custom to temporarily* place windfalls and other bagged fruit in it. An *American writer* (Mr. M. V. Slingerland) says:—"In one instance, in California, the openings in a fruit-room were *screened*, and nearly 16,000 codlin moths were thus trapped



Section of Grubby Apple.

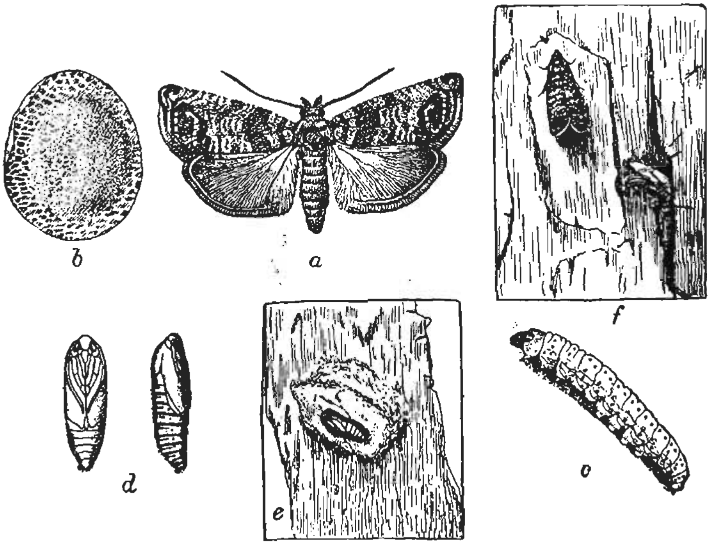
and killed between the middle of April and the end of August."

After the season is over, and all the fruit sent away, the house in which it has been stored should be thoroughly fumigated with sulphur; by this means very large numbers of grubs can be destroyed. To fumigate the room it is, of course, necessary to close all doors and windows and to block up the chimney; then make a fire of charcoal on top of a tin (or *something else to prevent the floor from burning) in the* middle of the room, and when it is well alight put the sulphur on it.

Whatever means are adopted to fight this pest, they should be carried out thoroughly, not in the perfunctory way they are by *so many of our orchardists. If we allow that half the* moths are females, and that each of these on an average lays *100 eggs (a low estimate), it is plain that* every grub allowed to escape, and eventually become a moth, means a loss of an average of 50 apples the following season, and, of course, more in ensuing seasons.

It is pleasing to note the methods one of the fruit boards in the Huon district adopts to keep this pest in check. Each of the known-infested orchards is carefully watched and properly bandaged. During the season the inspector and some of the members of the board examine the growing fruit; all grubby apples and pears found are cut open, and, if the grubs have left them, the bandages and rough bark of the trees are searched until the culprits are found. In consequence of this treatment, their district is one of the most lightly infested in Tasmania, and they are periodically able to report as clean formerly infested orchards.

Where the orchard or district is clean the greatest care should be taken to prevent it from becoming infested. Infestation is usually caused through second-hand cases or bags which have contained fruit. Grubs, however, are sometimes transported in carts which have been used in carrying fruit;



a, the Moth (enlarged); *b*, Egg (greatly enlarged); *c*, Full-grown Larva (slightly enlarged); *d*, Pupæ (slightly enlarged); *e*, Pupa, in cocoon; *f*, Moth, on bark, and empty pupa skin (after Simpson).

sometimes in clothing. More than once grubs have been found in the lappets of coats or overcoats. Of one thing each orchardist in Tasmania may be almost certain, and that is, that once the codlin moth has obtained a foothold in his orchard, it is bound to increase until his whole crop is destroyed by it, unless he takes vigorous steps to keep it in subjection.

The codlin grub, when full grown, measures about two-thirds of an inch in length, and is white with a more or less decided pink flush. When it leaves the apple it spins a flimsy cocoon in some sheltered situation; the cocoon nearly

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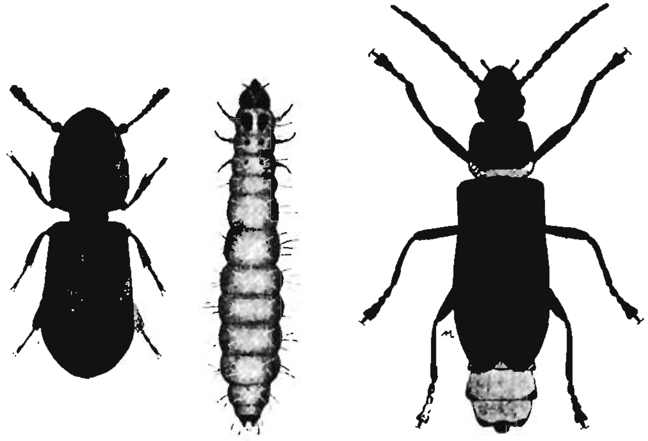
always being covered with dirt so as to help conceal it. In this cocoon, in Tasmania, it remains for about 11 months, usually curled up like the letter J; it then turns into a pupa or chrysalis of a brown colour, and about half an inch in length. In this stage it remains about 10 days to about three weeks, after which it becomes a moth. The moth is about half an inch in length, and not quite an inch across the expanded wings. Of these, the front ones are of a mottled slaty brown, with a metallic patch at the tips; the hind wings are paler, and without the metallic tip. The female lays her eggs usually at dusk or during the night, but occasionally during the day if dull and cloudy. She seems to prefer trees with heavy foliage, so that the apples on these are nearly always more noticeably attacked than on those where the foliage is at all sparse. Her flight is fairly rapid, but she soon settles down after being disturbed.



a b c

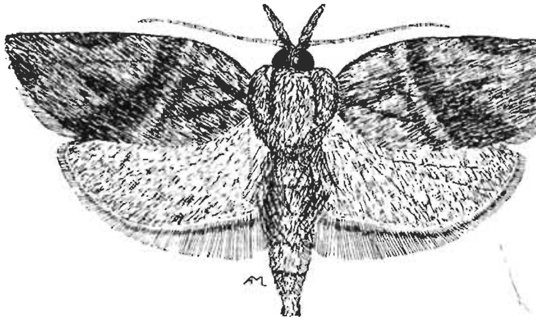
Insect Enemies of the Codlin Moth (all enlarged).

a, *Tenebriodes mauritanicus*.
b, Larva of same.
c, *Telephorus pulchellus*.

Codlin grubs are attacked by a great many other insects in various parts of the world; in Tasmania alone 7 or 8 species are known to feed upon them, but on the whole they do not do much good. The principal one is a beetle known as *Tenebriodes mauritanicus*, which, with its larva, may often be seen in codlin moth bandages; a well-grown larva will eat 1 or 2 codlin grubs a day, and it will keep this up for months. Another species, known as *Telephorus pulchellus*, occasionally eats codlin grubs, and many species of the same genus have been recorded as attacking them elsewhere. Birds, rats, and mice also eat them.

The Light-brown Apple Moth.

The grub of this moth (*Cacaecia postvittana*, or, as it is sometimes known, *C. responsana*) has become unpleasantly familiar to many apple-growers in Victoria and Tasmania. The grub itself is of a dirty greyish-green colour, and rather more than half an inch in length when full grown. It attacks such diverse plants as the apple, pear, plum, apricot, peach, gooseberry, strawberry, potato, cabbage, chrysanthemum, rose, mignonette, boronia, and many of our native plants. When attacking leaves these are usually formed into a roll, or two or more leaves may be joined together. With the apple the grub usually joins a leaf to the fruit by means of silk, and under this leaf it works, eating patches out of the skin and flesh of the apple, especially in the vicinity of the eye, the patches being sometimes of considerable extent; occasionally, but not very often, it works right to the pips of the apple, and in several such instances has been taken for the codlin grub; it is, however, a narrower grub, and never with the beautiful rosy



The Light-brown Apple Moth (greatly enlarged).

flush that that grub almost invariably has. It often attacks stored fruit, and one grub will sometimes spoil half a dozen apples in a case, or even more. When attacking stored fruit the eye is usually selected, or the place where two apples touch.

When about to pupate, the grub often rolls a leaf up, spins a flimsy cocoon within it, and then turns to a chrysalis, but it often turns to a chrysalis between the skin of the apple and a leaf. In general appearance the chrysalis resembles that of a codlin moth, except that it is smaller, but the cocoon is of a very different texture, and the grub never gnaws away a portion of the bark (as the codlin grub often does) to help conceal itself.

The moth is about the size of the codlin moth, but the front wings are of a pale yellowish-brown, and slightly mottled; the hind wings are whitish, lightly-mottled with brown. The markings and size, however, are very variable, and the females are usually darker than the males.

There are several broods in a season, but being one of our native insects, this pest is kept in subjection by parasites more

than is the case with the codlin moth and many other introduced insects.

The moths are attracted in great numbers by any brilliant light, and this insect is one of the few that it really pays to trap by this means. An acetylene lamp will do very well, and should be placed on top of a wide flat dish, in which a thin film of kerosene is floating on water. It can also be trapped by hanging up tins in fruit trees with sugar and poisoned water.

Just as many females as males are attracted to lights (this is an important point, as with many other kinds of moths it is frequently only the males that are attracted in large numbers): the sexes can be distinguished by the front edge of the front wings of the male being slightly folded over near the base, the tip of the abdomen has a denser tuft of scales than in the female, and there is a long yellowish bristle on each side of the under-surface. These differences, although at first sight

A Fly parasitic upon the Light-brown Apple Moth and Codlin Moth (enlarged).

not very distinct, are soon picked out when many specimens are examined.

Spraying with arsenical poisons will often greatly reduce this pest in numbers, but the spray should be applied with force, especially to where the apples are in clusters; if applied as a mist, or very gently, the poison simply lodges on top of the covering leaves, which effectually protect the grubs; but with a coarse strong spray some of the poison will penetrate between the covering leaves and the skin of the apple, where the grubs can get at it. Two sprayings will be necessary, one in January, the other in February; The strength (if Paris green is used) should be at the rate of 1 pound of Paris green to 200 gallons of water, with the addition of a little lime to neutralise any free arsenious acid; and it should be kept continually stirred, otherwise the Paris green will sink to the bottom. The spraying should not be done on a hot day. This spray will also reduce the numbers of earwigs and tussock grubs where there are at all abundant. Frequently,

when the caterpillars of this moth have done feeding, earwigs will enlarge the holes they have made in the fruit.

The grubs of this moth are frequently destroyed by the maggots of a fly belonging to the genus *Masicera*. The same fly has also been reared occasionally from codlin grubs.

Small Looper Caterpillar.

Young apples (especially Five-crowned and New York pippins) and cherries are in some seasons rather severely attacked by small looper caterpillars belonging to a species of *Phrissogonus*.* At Hobart, Franklin, and New Norfolk many trees were seen on which fully half of the young apples had holes eaten in them. One caterpillar would often eat several holes in every apple on a bunch; at other times it would drive right to the core, but the holes were seldom more than one-eighth of an inch in depth, and were always perfectly circular in outline; usually a fluid oozed out of the holes after they were left. With the cherry, a hole was often driven straight to the kernel, and this was eaten completely out; but sometimes only small holes were eaten, as in the apple. In the majority of cases apples appear to be able to survive their attacks, although the scars are always traceable; but the cherries are destroyed, and soon fall.

The loopers are most numerous in November, and the moths in December and January. The looper is very variable in colour. In a common form it is of a very pale yellow with three pale brown lines (of which the central one is wider and darker than the others) along the back; in other forms it is green, with pinkish markings along the back, or entirely pale green or pale pink. On becoming full-fed it turns a pale bluish-green colour, and spins a fine web, usually cementing a few leaves together in doing so. When full-fed it is about two-thirds of an inch in length. The moths are rather less across the expanded wings, and are of a dark-grey colour, in places marked with brown, and with numerous wavy lines on the front wings.

Looper caterpillars are so called because they have a habit of doubling the body up into a loop as they move, almost as if measuring. In the United States they are often called span-worms from this habit.

The Emperor Moth.

The larvæ of the large emperor or eucalyptus moth (*Antheræa eucalypti*) are occasionally to be seen on the apple. In its native state it feeds principally on various kinds of eucalypts, but it is so severely parasitised by various insects that it is seldom seen; and this is very fortunate, as it is so large and voracious that if at all common on apple trees it would do a great amount of damage. A correspondent, for instance, in sending a specimen of it wrote, "accompanying caterpillar ate up a whole two-year old apple tree single-handed."

The larva measures between 3 and 4 inches in length when full-grown, and is of a green colour, with reddish projections, tipped with blue, on most of its segments. Birds do not seem to care for it.

* Mr. George Lyell, Jun., to whom some specimens were sent in 1901, stated that the species was probably an undescribed one, close to *pyretodes*.

The moth itself is a magnificent insect, mostly pale brown in colour, but in places yellowish, red, and grey, and with circular peacock spots on both surfaces of its wings. It is probably the finest (although not the largest) insect in Tasmania.

The Tussock Moth or Hairy Caterpillar of the Apple.

There are many kinds of hairy caterpillars (the larvæ of tussock moths) in Tasmania, and some are capable of doing a considerable amount of injury to fruit trees, especially the apple. The one which is most in evidence is known as *Teia anartoides*, and is a native of Australia and Tasmania, where in its wild state it usually feeds on various species of eucalypts and acacias, and trees in the bush may sometimes be seen from which the whole of the leaves have been stripped. In the garden it may sometimes be seen on roses, geraniums, and other plants.

The caterpillars almost always work in clusters, so that after they have been eating for a little while their work becomes very conspicuous.

There are at least two broods in a season, the first appearing in December, the second in February and March. The second brood is the more destructive, as, in addition to eating the leaves, the caterpillars will often eat a considerable amount of the apples themselves, these becoming so badly marked as to be worthless.

These insects obtain their popular names of hairy caterpillars or tussock moths from the fact that the larvæ are densely covered with long hair, which, in many species, becomes tufted, or like tussocks, in places. Very few birds will eat such caterpillars, as the hairs have an irritating effect upon them, and even men who have handled them frequently suffer from intense irritation at the spots where the hairs have touched the skin. The hairs, however, do not protect the caterpillars against the attacks of insect parasites, of which many kinds attack them, both in Australia and Tasmania.

The caterpillar of *Teia anartoides* is from an inch to an inch and a quarter in length when full-grown, and densely covered with hairs. Near the tail there is a loose tuft of longer hairs than usual; near the head two other loose tufts; and about the middle of the back four dense upright tufts of rather short hairs.

When full-fed it spins a flimsy, whitish, silken cocoon, usually between two or more leaves, and in this it turns into a chrysalis, and later on into a moth.

The male moth is a beautiful insect, measuring about an inch across the expanded wings. The front wings are mottled with grey and light and dark brown. The hind-wings have a large basal patch of orange yellow, and outside of this, a broad black band, with the fringes yellowish. It possesses also beautiful feathery antennæ.

The female moth, on the contrary, is without wings (except two minute appendages on each side, which are closely pressed to the body, and look more like scales than wings), and soon after coming to maturity proceeds to lay eggs, these usually being laid on her empty cocoon. The eggs laid are very numerous, ranging between 500 and 1000 for each female. They are small, white, round, and nearly all are fertile, although but few (probably not 10 per cent.) of the caterpillars hatched from them attain maturity.

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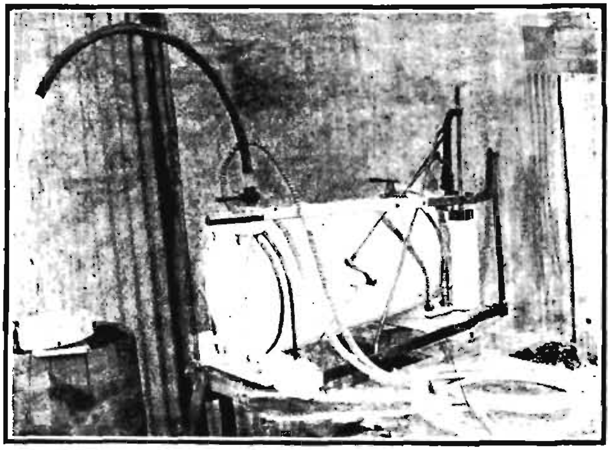

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In the orchard, when at all bad, they can be destroyed with any of the arsenical sprays used against the codlin moth, and being exposed during the whole of their feeding stages they are easily got at. But it is seldom that they are really so bad that an entire orchard needs spraying for them, although working in clusters they may do a considerable amount of damage to the individual trees attacked.

The Boll-worm.

This is the name by which the caterpillar of a very destructive moth (*Heliothris armigera*) is known in the United States, where it is very destructive to cotton-bolls. In New South Wales and Queensland it is known as the maize moth, on account of the great amount of damage the caterpillars often do to the stalks and cobs of maize. In India the poppy is seriously attacked by it. The caterpillars attack an immense variety of plants, including fruits, most of the garden vegetables, ornamental flowers, grains, &c. They may frequently be taken feeding on peas (inside the pods) inside tomatoes (although the grub of another moth—*Mamestra composita*—is still more common in the tomato), in cobs of maize, &c. During certain seasons they may be seen doing great damage to young apple trees by eating the leaves and terminal shoots, and in many cases eating large holes out of the apples themselves. Sometimes one of these grubs may be seen completely buried in an apple. One grub will frequently destroy several apples, and, on young trees especially, some of them completely destroy the new growth, so that the trees are practically checked for one year. A Franklin orchardist wrote of these caterpillars that "they are making terrible havoc on the young trees, biting the limbs off about 2 or 3 inches from the tops, and perforating all the leaves and destroying the apples." A farmer at Moonah also said that in December they were eating grass, oats, &c., and that the starlings and sparrows were taking immense numbers of them to their nests.

In various parts of the world this moth is reported as having from two to five broods in a year; in Tasmania there are probably but two.

Each female moth has been estimated to lay from 300 to 500 eggs. These are small and fluted, and are attached singly to the plants attacked.

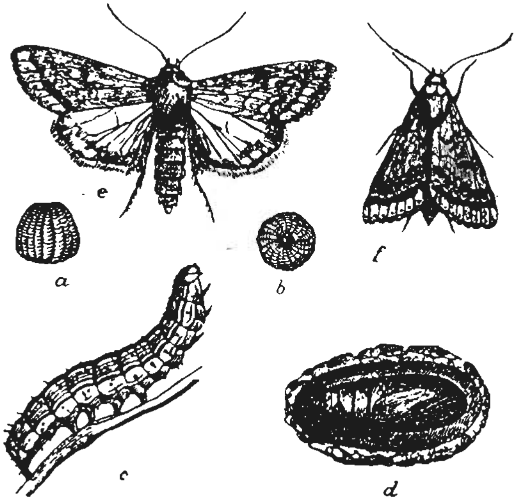
The grubs when full grown are about an inch and a half in length, and vary greatly in colour, some specimens being pale green throughout, with very indistinct paler stripes. Others are marked with distinct black stripes from the head to the tail; there are also small warts and a few hairs distributed over the body. The stripes, however, are usually very distinct, and even in the very pale specimens can always be traced.

The chrysalis is of the usual form, and of a pale, chestnut-brown colour. It is usually enclosed in a flimsy silken cocoon, which is rendered very distinct by small pieces of leaves or earth being attached to it.

The moth measures rather more than an inch across the expanded wings, and is of a pale yellowish-grey colour, with the hind wings dark outwardly; but, as with the grubs, there is considerable variation in the colour and markings. On

favourable nights they are attracted to lights, but very little can be done against them in this way.

Where they are eating young apple trees the grubs can be easily collected and destroyed by the use of an ordinary umbrella. This should be held upside down under the tree, which should then be bent over and strongly shaken into it, when all the grubs will fall down, and can easily be gathered up and destroyed. On young trees this operation takes no more time than spraying, and it is better than spraying, because even when the grubs are poisoned it takes a certain quantity to destroy them, and leaves and fruit have to be eaten for the poison to enter the system. But, of course, this plan is not practicable for the larger-bearing trees. For these probably the best remedy will be spraying with Paris green—1 lb. to



Heliothris armigera—*a*, *b*, Eggs; *c*, Larva; *d*, Pupa in cocoon; *e*, *f*, Moths (after J. B. Smith).

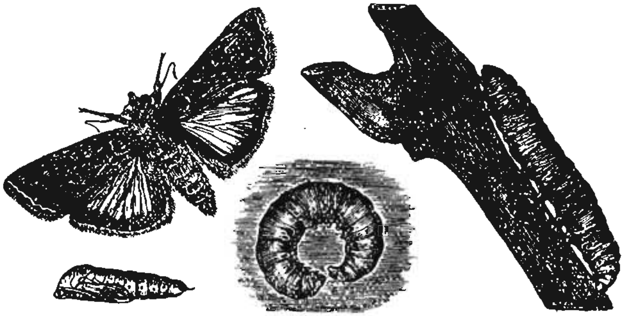
200 gallons of water, with a little lime added to neutralise the free arsenic. Very good results have been already obtained with this poison.

These grubs appear sometimes in immense armies, and practically devour everything in their way. It is not, however, the insect known as the "Barley Grub" in Tasmania, although it belongs to the same family of moths (the *Noctuidæ*) as does that species.

The Earth-coloured Cut-worm.

Cut-worms (or surface caterpillars, as they are sometimes called) are often very destructive. They all belong to the family of moths known as *Noctuidæ*, and as a rule live underground during the day, coming out at night-time to feed.

There are many of them in various parts of the world, but the present species (*Agrotis munda*) appears to be confined to Australia and Tasmania. In Australia it is especially destructive to the grapevine, but there are few plants which escape its attacks. In Tasmania it has been seen attacking the hop, tomato, potato, strawberry, apple, pea, cabbage, rape, swede, &c. In some of the Huon districts it has done a lot of damage to nursery stocks by eating buds and holes in the stems. In the New Norfolk district in some places it has been very destructive to the hop-bines. Many of these have been completely ringbarked and killed, large patches of bark being eaten from the first 2 feet above ground, and sometimes the bine being eaten completely through. At one place the owner thought he was saved from serious loss only by setting a number of men spraying as soon as the work of the grubs was noticed. The spray used was Paris green, just as for the codlin moth, and directed on to the lower 2 feet of the bines. This was very successful, most of the grubs being destroyed.



Agrotis munda—Moth, Pupa, and Larvæ.

With the apple and the grapevine, leaves and buds are sometimes eaten, but the grubs appear to prefer the bark to any other part. With the strawberry, large holes are eaten out of the berries. With swedes, the leaves are badly riddled, only the midribs being sometimes left, whilst large holes are eaten out of the swedes themselves. Young pumpkins, maize, cabbages, &c., are sometimes eaten off as soon as they appear above ground. Potato plants are often ringbarked by cutworms, either level with or just below the surface of the ground. The result is almost always the death of the plant.

The grubs when full-grown measure about an inch and a half in length. They are of a very dingy earthen colour, and are easily overlooked, even when specially looked for. When disturbed they usually coil themselves up in a circle. They pass from four to six weeks in the grub stage, and consume considerably more than their own weight in a night, so that with nursery stocks, &c., one grub alone is capable of doing a considerable amount of harm, as it destroys far more than it eats. In Western Australia hundreds of these grubs have been seen under a single grapevine. Here, also, they have been seen in dozens at the roots of fruit trees and about vegetables.

They seldom bury themselves more than an inch below the surface. When full-fed they form an earthen cocoon, in which they change into the chrysalis. This is pale brown in colour, with a small spine at the tail end.

The moth itself measures rather more than an inch across the expanded wings. The front wings are pale brown, mottled with darker brown and grey. The hind wings are paler, but dark outwardly. They are often (especially the males) attracted to lights.

One of the best remedies for these grubs is the bran and arsenic mash, and of this many tons are used to protect the grapevine in Australia.

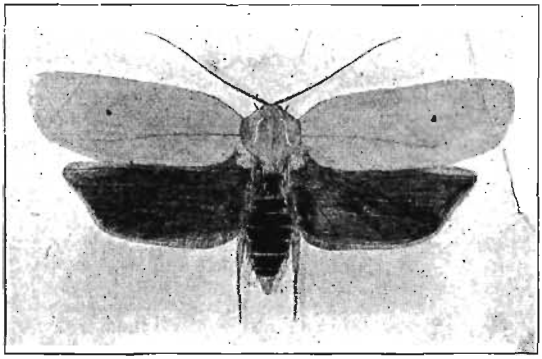
Particulars as to its preparation are given later on. The mash is made up into balls about half the size of an egg, and placed at the roots of the plants attacked. The grubs seem to prefer this to their natural food.

Where it is not considered advisable to use the mash, the grubs can be destroyed by spraying the affected plants with Paris green or other arsenical poisons, but the mash should be used when possible, as it is much cheaper, more easily prepared and distributed, not at all liable to injure the foliage, and equally effective.

Where the place is not very badly attacked and fowls can be turned in, they will be found of considerable benefit, as in scratching about they uncover and eat many of these grubs.

The Cherry-borer.

There are many insects which, during their larval stages, live within the trunks or limbs of trees, and do considerable



The Cherry-borer.

damage to them. In Tasmania the only timber-boring insect which is troublesome to fruit trees is the cherry-borer (the grub of a large moth known as *Maroga gigantella*, or sometimes *Cryptophasa unipunctata*). This grub bores within the limbs of the cherry, and protects the outside of its tunnel with a covering of web and triturated wood, &c. They are some-

times so numerous that the trees are seriously injured. The grub is greyish, and each segment has a number of pinkish spots, which, on the middle of the back, are large and transverse. The head is blackish, the segment behind it is yellow and scattered about are numbers of long hairs. When present in a small limb this is best cut out and destroyed, but when in large limbs the pest can be destroyed by inserting a wire down its hole till the grub is pierced, or by injecting a small quantity of kerosene into the hole. The pear, apple, quince, plum, and hawthorn are occasionally attacked by this insect, but are never seriously injured by it. It is indigenous to Australia and Tasmania, and may frequently be obtained in the prickly wattle and many other species of acacia. The *moth itself measures from an inch and a half to 2 inches* across the expanded wings; the front wings are white, each with a small dark spot, the hind wings (in Tasmanian specimens) are almost entirely dark. The moths (in Tasmania) appear in January and February.

The Underground Grass Grub.

The most destructive indigenous insect of Tasmania is undoubtedly the one commonly known as the "Underground Grass Grub," or "Corbie"; the larva of a moth named *Oncoptera intricata*. Several stockowners have estimated their losses due to this pest as amounting to hundreds of pounds in certain seasons. Many in the north and north-west of Tasmania state that it is impossible to lay down permanent pasture on account of the pest, and that when such is attempted the grubs will always destroy the pasture by the end of the third season. Nor is this surprising when their numbers are taken into consideration. In one square foot of ground as many as 150 holes made by these grubs have been counted, and 50 to the square foot is quite a common number.

The superior grasses, such as English ones, appear to be taken first, whilst cocksfoot is left to the last. Thistles and dandelions are never touched.

Large patches, sometimes acres in extent, are almost or quite denuded of grass. The ravages extend over many miles, and there is probably no part of Tasmania that has been cleared for any time but is affected; nor is it only cleared land, for in many instances scrub land also is attacked.

A common impression held regarding the grub is that it feeds on the roots of grass as well as on the stems and leaves; but this is a mistake. It is true that in forming its tunnel it may go through roots, but then only because they are in its way. If it fed on roots we should find numerous tunnels branching off amongst the roots, but this is not the case; although the writer has examined many thousands of tunnels formed by the grubs, one was never seen that was anywhere divided, such as must have been the case had roots formed part of their food. Moreover, in no instance was grit found in their intestines or excrement, such as is invariably present in root-eating larvæ.

The grubs never seem to climb up the grass to feed on the tops, but always feed either on the butts of the blades or on the stems; the blades that are bitten off are sometimes carried into their tunnels, to be eaten at leisure. Mr. Lester, of Stonor, states that in one paddock he saw some time ago the grass, after rain, had sprung up to about 6 inches, when it was cut down by these grubs as if with a scythe.

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On examining some patches eaten bare by these grubs, it was noticed that the roots formed a turf 4 inches in thickness. Below this was soft sand with no roots whatever, and in which the grubs were numerous. Where the ground has been eaten bare, however, frequently a considerable space may be turned up with a hoe without finding a single larva, although their tunnels are numerous.

The grubs in confinement become cannibals, and there appears to be no doubt whatever, both from their conduct then and from remains found in the open, but that they readily become cannibals when pressed for food.

Where they are very numerous, and the ground has been eaten bare by them, undoubtedly many of the larvæ are starved to death. In such cases it may be frequently noticed that horse and cow dung has been eaten by them; never from the top, but always from the part resting on the ground, where large cavities are frequently eaten out. Soft rotting wood is also frequently eaten by them when very hungry.

Heavy clay land seems to be less to the fancy of the larvæ than loam, or even sand, but no soil appears to be too hard for them. They seldom appear in land ploughed the previous season, but they have been seen even in stubble. At Stonor, a piece of land was completely under water in August, but in the following December was badly infested.

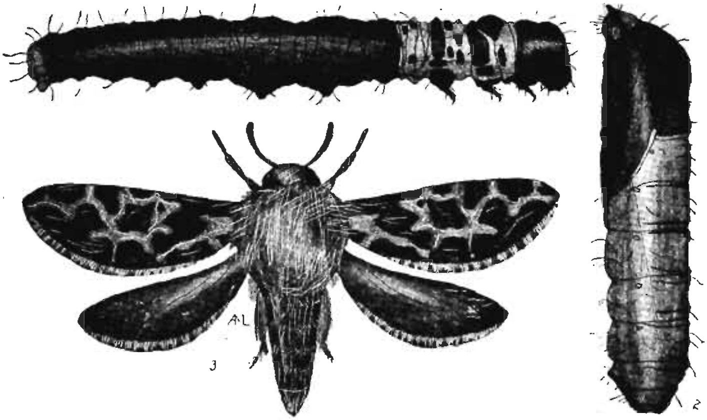
The larvæ when feeding lie almost perfectly flat. Healthy grubs never come out till the evening, and seldom before 9 o'clock. They are in full force by midnight, and disappear before sunrise. To see the larvæ feeding examination should be made on bright moonlight nights. They are extremely frightened of the light of a lantern, and as soon as its rays of light fall on them wriggle backwards into their holes. If the lantern be so held that the light is directed forwards, very few grubs will be seen, although the ground may be swarming with them. Moreover, such grubs as are seen will be either stretched out to their full length, and feigning death, or their heads will be seen disappearing into their covered ways. But if the lantern be held so that the light is not projected forwards, but sideways, very large numbers can be seen; but the majority of these will almost instantly disappear as the light falls on them.

Perfectly healthy grubs are never seen above dry ground during daylight. Should any grubs be seen it may be taken for granted that they are diseased, or dying with hunger, or from the attacks of parasites.

The grubs first hatch out in April, and may then be seen in small colonies under stones, logs, cowdung, &c.; they will often form a thin sheet of silk on the under-surface of stones, &c., but at this time do not appear to form tunnels in the ground. The writer is not in a position to state when the tunnels are first made, but Mr. Box, of Lilydale, states: "In the month of June I found them (the grubs) just under the surface of the ground, about half an inch long. In July and August they had increased in length to an inch and a half, burying themselves in the ground, and covering their holes with a web."

From the time the grubs are half-grown till their final change, however, it is certain that each grub constructs only one tunnel; in proof of this the following reasons may be given:—The tunnel is often of great length, and constructed in very hard ground; the grubs feed solely at night time, and never far from the mouths of their tunnels; no grit is to be found in their intestines; when badly infested ground is ploughed out the land in its vicinity does not become more infested than previously; the prevalence of cannibalism and the fact that patches are eaten bare and constantly kept bare.

This matter is more important than appears at first, because if a grub was capable of making a second tunnel after being driven out of a first, ploughing them out would be useless, or almost so, whilst as it is in some places it will pay well to plough them out.



(1) The Grub; (2) *the Chrysalis*; (3) *the* Moth.

The Underground Grass Grub (enlarged).

The grubs are nearly all full-fed by the end of December, but a few have been seen as late as early February.

The tunnels are never wider than an ordinary lead-pencil, and vary in length according to the hardness of the ground. In hard ground they are from 3 to 6 inches long, but are usually about 4; in very soft ground they are seldom less than 9 inches in length, and they frequently go down more than a foot.

Where food is abundant the tunnels are usually heavily lined with silk, but where the food is poor the silk is much less in evidence.

The tunnel is usually at an angle for the first half-inch, but after that generally goes straight down or with a very slight curve.

From the mouth of the tunnel a sort of covered way is constructed on the surface; this covered way is roofed with bits of dried grass and excrement cemented together with silk.

It seldom extends more than 6 inches from the tunnel, and the grubs seldom go more than 6 inches from its exit. On being alarmed, although they proceed backwards, they never fail to reach its entrance.

Heavy rain destroys the covered ways, so that the entrances to the tunnels are exposed; if the grubs are not full-fed the damage is repaired at night time, but if they are full-fed or have changed to pupæ the holes are left exposed.

It is not known for what purpose the covered ways are made. They can be no protection whatever against parasitic hymenoptera or predaceous ground beetles, nor against rats, mice, and bandicoots, and they are of too flimsy a character to stop parasitic flies. Possibly (by concealing the entrances to the tunnels) they are used as a partial protection against birds.

The grub, when full-grown, is about 2 inches in length, and about two-thirds the thickness of an ordinary lead-pencil. It is then of a dark, dirty green colour, and each of its segments (except the head) is supplied with a number of small warty lumps and a few short hairs. In addition to three pairs of true legs, it has four pairs of pro-legs or claspers in the middle of the body, and one pair at the end. Soon after becoming full-fed it ejects all its undigested food and excrement, and casts its skin, when it becomes somewhat smaller in size, and of a whitish colour.

The pupa is seldom more, and is usually slightly less, than an inch in length, and is of equal thickness throughout, except at the two ends; its abdomen is of a yellowish colour, the thorax of a light reddish-brown, with the head slightly paler: from the head there is a curious little angular projection. It remains perfectly upright in the tunnel, without forming a cocoon, and is able to wriggle up and down it at pleasure; when about to change to the moth it ascends to the summit of the tunnel, and leans slightly over in the covered way.

The moths are somewhat variable in size, measuring from 1⅓ to fully 2 inches across the expanded wings, and in length from ¾ to 1¼ inch. The male is smaller and brighter-coloured than the female. Both sexes are of a dingy greyish-brown colour, but the front wings variegated with dull yellowish-white markings, occupying about half the surface, and of a peculiarly intricate character; the hind wings are much plainer, being supplied with wavy markings (only noticeable in perfect specimens) only at the top outer edge. The antennæ or feelers are short, rather stout, and of a yellowish colour. The sexes can readily be distinguished by the legs; in the male each of the hind legs is supplied with a long, thick, curved bundle of creamy-yellow hairs; in the female these bundles are absent.

The first moths are to be seen early in January; the last in early March. They appear suddenly. A person may be passing through a paddock or scrub land and not hear one, when all at once they are to be heard and seen all around. Their flight is from 3 to 10 inches above ground, and seldom more than a foot, unless when flying to a spot some distance off.

The noise they make is much like that produced by many swift-flying beetles, and in places where they are very

numerous the sound is much the same as that produced by several swarms of bees.

The period when the moths are most numerous and easily caught only lasts about one quarter of an hour. The whole time of flight does not last one hour, but during that period many thousands can be easily captured.

When flying, the moths appear to be much smaller than they really are, and to be of a pale yellowish colour; this appears to be owing to the rapid vibration of their wings; it is also this rapid vibration that makes the noise.

Early in February they come out at 7.50 p.m.; by 8.10 p.m. very few are to be heard flying, and not one ten minutes later; but up to 9, a few are to be heard scuffling in the grass.

This scuffling sound is sometimes made early in the evening by the males struggling with the females, but after 8.30 p.m. it appears to be made entirely by the females. The buzzing sound is made solely by the males.

The flight is solely for the purpose of mating; mating takes place on the ground. The pairs, when mated, are mostly concealed in tussocks of grass, and are very difficult to find. The female appears to make no noise when flying, and quite probably the majority of them never use their wings.

Every specimen of many thousands that the writer has taken on the wing has been a male (the sexes are easily distinguished by the long tufts of hairs on the legs of the males, and by the larger abdomens of the females). During the day numerous specimens are to be found under logs, stones, and bark, and hidden in tussocks of grass and rushes, but these are invariably males.

It is probable that the female only lives one night, and that as she emerges from her pupal skin and comes out into the open she is pounced upon by a male. The males may sometimes be seen in such numbers that they form struggling masses, frequently the size of cricket-balls, around single females.

As soon as coupling is over the female lays her eggs. These are deposited three at a time, and close together, in any position where they can be sheltered: she lays her eggs when on the ground,* and usually deposits her entire load in but two or three places. When all her eggs are laid she dies, but her abdomen remains more or less inflated. Occasionally dead females from which all the scales have been rubbed may be found.

The abdomen of the female appears to be occupied entirely by the eggs, and when full extends beyond the wings for some distance. In the male it either just passes or scarcely reaches the tips.

The eggs, when first laid, and when in the body of the mother, are of a creamy-yellow, and are briefly elliptic in shape. The shell, under a magnifying glass, appears to be perfectly smooth. Some time after being laid they change to a deep, glossy black, and slightly diminish in size.

Under a stone, covering not quite 1 foot of ground, five lots of eggs were seen, and they can be found under almost every log, cowpat, stone, piece of bark, or rag lying on the ground.

* It has been stated that she lays her eggs whilst flying, but this is quite an error.

These clusters contain from 100 to about 300 eggs. The eggs in appearance are like minute glossy, black beads, but without a high polish. The eggs in one female were counted, and were 332 in number, but it is probable that the number of eggs laid varies according to the amount of food consumed by the grubs.

The most useful ally that we have against the grubs is undoubtedly the bandicoot. Very large areas may be seen in which the small holes made by these animals when searching for the grubs are exceedingly numerous; in some places as many as 10 to the square foot. Mr. F. A. Stanfield, of Rokeby, states that bandicoots will also frequently work round peas and onions to get at them.

The habits of the grubs would appear to be sufficient protection against all day-flying birds, but this is not the case, as magpies eat large numbers of them. In the *Agricultural Gazette* for January, 1901 (p. 144), appears the following from Railton:—"Mr. Jas. Singleton stated he had taken great interest in the way the black and white magpies destroy them in great quantities. He stated he had watched the birds in the paddock searching for the grubs' holes, and as quick as lightning would stick their bills into the ground as far as they could get them, and out came a long grub, and the birds never seemed to make any mistakes. The magpies pick up the grubs about one dozen at a time, and fly to feed their young. When hunting for the grubs in the paddocks they drop all the grubs they have in their bills and catch each grub with empty bill, and repeat this all day long in the breeding season. He considered the magpies their best friends."

Mr. Briggs, of Scottsdale, writes that the black-headed cuckoo, or summer bird, feeds on the grubs early in the morning, and crows, starlings, and the whistling shrike-thrush also eat them.

No Hymenopterous or Dipterous parasites were reared from the grubs, but this was probably owing to the fact that it is almost impossible to keep them alive in captivity.

Of predaceous ground insects, the one that appears to eat most of the grubs is a shining, coppery-black beetle, about two-thirds of an inch in length, and known as *Promecoderus ovicollis*. This beetle is widely distributed in Tasmania, and is especially numerous in the districts where the grubs are most numerous (about Parattah and Mole Creek it can be obtained in thousands). The adult beetles may frequently be ploughed out, and during the day they may often be seen under logs, under patches of dry cowdung, stones, &c. The larvæ may also frequently be ploughed out, and appear to be equally as useful as the adults, or perhaps even more so. The beetles during the day are seldom to be seen more than an inch in the tunnels, as when a grub or pupa is seized it is dragged to the mouth of the tunnel and there eaten at leisure. The beetles also feed on the abdomens of the moths themselves, apparently never touching any other parts of their bodies. Scorpions eat the moths, and possibly also some of the grubs.

One of the most interesting facts in the life history of this insect is that a small red ant (very common under stones about Launceston and other places in Tasmania) is in the habit of gathering up the eggs of the moth and storing them up in its nests. There appear to be spaces in their galleries specially enlarged to receive the eggs; one of these spaces was estimated to contain over 1000 eggs. Here they are kept till the grubs

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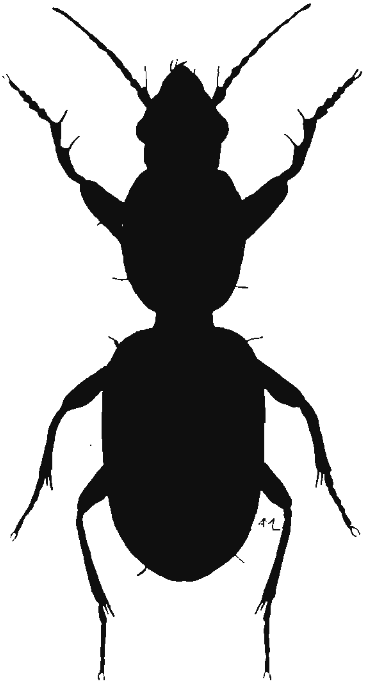
hatch out, when (judging by appearances) they are immediately eaten, and (either then or soon afterwards) the empty shells are taken to the mouth of the nest and thrown out.

The grubs are also killed by a parasitic fungus,* especially in wet seasons. The grubs apparently feed on the fungus at night time, and some of the spores lodge in the jaws, as the fungus with these insects invariably starts growth from the head.

In ground where it will pay to do so, undoubtedly most, if not all, of the grubs can be destroyed by ploughing; but short



A Useful Beetle *(Promecoderus ovicollis)*, enlarged.

of this, over extensive areas it is difficult to suggest any remedy. Great numbers could probably be destroyed by driving sheep (after 9 o'clock at night) in close masses over the infested ground; but the driving should be done very quickly, otherwise the grubs would disappear into their holes. It would be useless to catch the moths, as only males can be readily caught, and as the males greatly outnumber the females, it would simply mean that the survivors would have an easier time to find mates.

* *Cordyceps gunnii*, according to Mr. Rodway.

In places where flat ground can be flooded it is advisable to do so, as the grubs will thereby be hunted out of their holes, and birds will feed ravenously on them. At one Branch Board meeting it was stated that pigs were especially fond of the grubs when driven out of their holes by the ground being flooded.

It also appears probable that where the land can only be moderately soaked that much good would result, from the fact that the parasitic fungus would be given a much better chance for its propagation.

Where the pest has attacked small areas, such as lawns, the grubs can nearly all be destroyed by spraying with Paris green or arsenic and soda. In fact, it would probably pay to spray large areas of flat ground where a machine, such as the Strawsoniser, could be brought to work. It would, of course, be necessary to keep stock off this sprayed ground for a fortnight; but after that time there would be no danger to them.

It has been suggested that the moths could be destroyed by means of lights, but they are not attracted by it, and in fact the time during which they fly is so limited that twilight has not faded and no light shows up distinctly. They even seem to avoid light, as when moths were heard fluttering in the grass and a light was turned on them, they invariably tried to escape.

Cold appears to suspend animation in the grubs, but not to destroy them. At Glenora once a farmer saw in the early morning thousands of the grubs frozen and stiff with frost, and birds eating them; but soon after sunrise the sun thawed them, and they retreated to their holes.

The Barley Grub.

A very troublesome insect some years in Tasmania is one known as the barley grub, or army caterpillar* (*Mamestra ewingi*). In its native state it feeds on grasses and other low-growing plants. When attacking cultivated grains, however, it sometimes renders the crop quite useless, as its habit is to nip off the ears of barley and wheat. It climbs up the grain till it comes to the head, which it usually nips off, so that a badly-attacked field may sometimes be completely stripped; sometimes it eats the outer portions of the heads of wheat or oats, but nearly always the part attacked is just below the head.

Occasionally these grubs travel about in immense armies, usually all moving irregularly in one direction. When travelling from the bush into a field of grain they can be prevented from attacking this if a deep furrow is ploughed at right angles to their line of march, with the sod turned away from it, and a deep hole dug in the furrow at intervals. The grubs, on coming to the furrow, fall into it, and instead of climbing up on the other side will crawl along the furrow till they come to one of the holes, and in these holes they can be destroyed in millions. Or large numbers can be destroyed by rollers, or by heavily poisoning a strip of grass which they must pass.

* There are many insects in various parts of the world known as army caterpillars or army worms.

At Scottsdale, on one occasion, the grubs after destroying a crop of Algerian oats, travelled to an orchard, where they bit off the apples at the stem when they were about the size of walnuts. Sometimes they only partly bit the stem through, so that the apple grew on for a time, but afterwards fell. They also bit off many leaves. They never seemed to eat the leaves or apples, but only the stems.

The grub is of a greyish colour, with several dark stripes on the back and sides. When full-grown it is about an inch and a quarter in length. It then constructs a cocoon in the earth, and turns into a chrysalis; this is about two-thirds of an inch in length, brown, and with two minute spikes at the tail. The moth itself is rather more than an inch across the expanded wings, of a slaty-grey colour, with somewhat mottled front wings. A closely allied species (*M. composita*) is very destructive to the tomato.

This insect is usually kept in check by numerous parasites, principal among which are several species of ichneumon flies and true flies. A bug (*Pentatoma*) and two kinds of beetles (*Calosoma schrayeri* and *Promecoderus ovicollis*) also eat large numbers of them. But some years these parasites are much less numerous than usual, with the result that the following year the pest again appears in extraordinary numbers.

Starlings occasionally congregate in immense flocks to feed on these insects.

The species is known from New South Wales and Victoria, as well as from Tasmania.

The Potato Moth.

The little potato moth (*Lita solanella*) is perhaps the worst insect the potato-grower has to contend against, especially in warm countries, as when in numbers it will frequently destroy almost the entire crop, the tunnels of its grubs, filled with web and excrement, going through the tubers in all directions, and rendering them unfit for human consumption. It also does considerable damage to the leaves of tobacco and occasionally of tomatoes.

It is not only the tubers that are attacked, for the grubs prefer the leaves. When the tops die off or are cut down by frosts, however, a change takes place, as the grubs desert the leaves in large numbers and wander about the paddocks, entering any tubers they come across.

When depositing her eggs on growing plants, the moth usually places them close together on the under side of a leaf, close to the main or one of the smaller ribs; the grub, on hatching, immediately eats its way into the leaf, hollowing it out in patches, but leaving the skins; frequently two or more leaves or leaflets are cemented together with web; and they will often leave one part of a leaf for another part. A common opinion held is that the moths crawl down through cracks in the ground to lay their eggs on the tubers, but this is probably erroneous, although a grub may occasionally reach the tubers in this way, after the tops have been cut down by frosts. The grub will always, if possible, enter at an eye; sometimes a number of grubs enter at the same eye, but their tracks separate almost immediately. When in the shed the moth lays her eggs in clusters about the eyes, and the eggs hatch in about a week's time.

The grub will often turn into the chrysalis form inside a leaf, especially where two leaves are joined together; if it has left the leaf it will attach itself to almost anything, and in a shed its dirty silken cases may frequently be seen sticking to sides of potatoes, of bags, in cracks of wood, or any rubbish that may be lying about.

The eggs are very small and glistening, and on account of their minute size are difficult to find. The grub is of a pale, dirty green colour, with a brown head, and measures about half an inch when full-grown. The pupa or chrysalis is pale-brown in colour, and is enclosed in a small silken cocoon, which is nearly always covered with dirt. The moth itself is a small grey insect, with front wings darker than the hind ones, a little more than half an inch across the expanded wings, and its body is about a quarter of an inch in length. Some years it may be noticed that the moths are very numerous, and do much harm, whilst in the next they are comparatively scarce. This is largely due to the multiplication of parasites, climatic influences, and also, no doubt, to bacterial diseases.

The destruction of potatoes by these grubs may be greatly minimised by observing proper precautions. It is very easy to detect their presence, as the leaves are brown in patches, and the moths may often be seen flying along the ground, never rising to any height, and frequently resting on clods, &c. Where a paddock is noticed to be infested the tubers should be dug out earlier than they usually are, before frosts if possible, and either bagged or buried in heaped-up trenches immediately. The main thing to observe is, that once the tubers are out of the ground, to make it as difficult as possible for the moths or grubs to get at them. If stored in a shed, lime lightly sprinkled over the tubers has a deterrent effect upon the moths.

Very large numbers of grubs and pupæ can be destroyed by harrowing up and destroying the tops, and the sooner this is done after digging the more will be destroyed. It would also be a good thing if pigs were allowed in the ground after digging, as they would eat all the tubers left behind, and which would then serve as traps for the grubs. No cheap way is known of destroying the grubs in the growing plants, as, not feeding on the outside, but within the leaves themselves, they are for the greater part of their lives protected against any spray which might be applied. The damage, however, done to the leaves of the potato by the grubs usually affects the tubers to but a slight extent; little attention, therefore, needs to be paid to the growing plants, provided proper precautions are taken when digging.

Setting potatoes badly affected by the grubs of the potato moth will be found almost useless, as the grubs nearly always attack the eyes, and in consequence very few plants will grow from such seed.

Green Caterpillar of the Potato.

In many parts of Australia the potato is often attacked by enormous numbers of the pale-green caterpillars of a moth, *Plusia argentifera*. In Tasmania no instance has as yet come under the writer's notice of whole paddocks of potatoes being destroyed by them, as has often happened in Australia; but it is one of those pests (such as *Heliothis armigera*, of which

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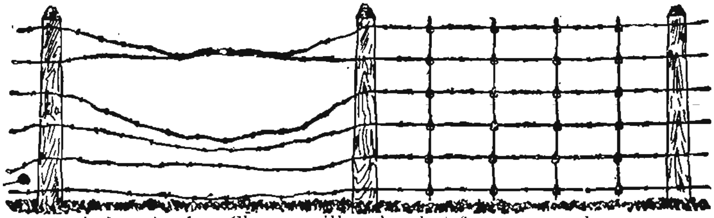

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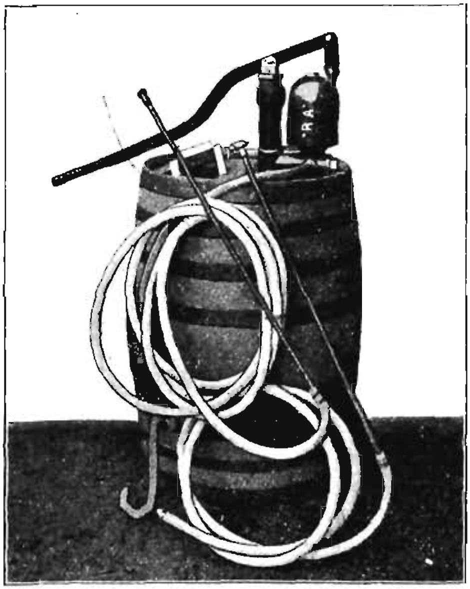

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only too much was seen in the summer of 1903) that are liable to appear in enormous numbers in one season, and may not be again noticed for several seasons. It is widely distributed in Tasmania, and the moths may often be seen at lights on sultry nights.

When few caterpillars are on a plant the leaves have patches eaten out of them, but when in numbers every leaf is stripped, only the midrib (and sometimes not even that) being left. The plants, in consequence, have a skeletonised appearance, and the tubers are very much smaller than they otherwise would be if the leaves were untouched. Other plants than the potato are attacked, among which may be mentioned tomato, stinging-nettle, thistle, cabbage, beet, bean, pea, rhubarb, tobacco, grapevine, dock, sunflower, chrysanthemum, turnip, radish, and rose. Large patches are eaten out of the leaves and flowers, young shoots are eaten, and the bark of the older growth gnawed away; when really bad there is probably no garden pest which causes so much havoc in a short time.

The eggs are white, small, flattened, and laid irregularly on the under-surface. The caterpillar is pale-green with whitish markings; the back has a white stripe extending on each side from the head to the tail, and leaving a distinct green stripe down the middle; the sides have three or four feeble, slightly waved stripes, and numerous very minute whitish specks; a few hairs (scarcely visible unless the specimen be viewed sideways) are sprinkled about; the head is pale watery-green. In old or diseased specimens the colour is greenish-white, and the markings are feeble or entirely absent. There are six small legs close to the head, and six prolegs (or claspers) close to the tail, two being at the extreme apex, and the others a short distance from it. Under a magnifying glass the prolegs are seen to be tipped with short pale hairs or bristles; a full-grown caterpillar will measure about one and a quarter inches. When about to pupate it spins a thin white cocoon about the roots of grass or rubbish, under logs, stones, &c. The cocoon will often be attached to a fibre, and it is often covered with coarse grains of sand. The pupa is rather slender, brown, and with no special features worth noting. The moth itself is about one and a half inches across the expanded wings, and the body is about two-thirds of an inch; the front wings are of a somewhat slaty-brown colour, and have a peculiar soft wavy lustre; they are also marked with bright silvery patches; the hind wings are pale inwardly, and clouded outwardly—their fringes are white, but at the base spotted with brown.

A very great number of the caterpillars (fully 90 per cent. at one garden examined) are affected by a bacterial disease, which, happily, greatly reduces their numbers; this disease causes the caterpillars to have a peculiar whitish puffy appearance, even when young. Shortly before death the caterpillar clings with its prolegs to a leaf or stalk; on death ensuing the colour gradually changes till it becomes a brownish-black, the legs are loosened and the body hangs perpendicularly, sometimes the anal prolegs loosen and that part droops over; the internal organs decompose and gradually drop down towards the head end, which becomes swollen, and in a day or two the skin either breaks a little before the middle, the tail portion remaining on the plant, or the whole body drops to the

ground and speedily vanishes; if it drops on a leaf a stain will be visible for a few days.

If there are no poultry about (when it would be dangerous to use), Paris green or other arsenical poison sprayed or dusted on the plants will largely minimise the damage done; it may, however, be required more than once, as there are several broods in a season; the poison will kill every caterpillar that eats it, one or two days being quite sufficient to demonstrate its use. The following paragraphs are quoted in the *Agricultural Gazette* of New South Wales (Vol. 4, 1893, p. 298):—

"A small caterpillar, about an inch long, of a green colour, with two white stripes along the back, has made its appearance in various potato fields in this district (Pambula, near Eden), in such numbers as to destroy whole crops in a short space of time (if not checked in its ravages) by eating away the leaves and stalks. Thanks to the Department of Agriculture an effective remedy for destroying the pest has been discovered, and has been used with great success by Haywood Bros. on their potato crop at Pambula Flat. Our reporter visited this crop yesterday, on the invitation of Mr. Haywood, and there saw the caterpillars lying dead or dying on almost every plant. The following is Mr. Haywood's method of treatment: 2½ lbs. of London purple was thoroughly mixed with a bag of slacked lime, after the latter was riddled through a fine sieve; then the mixture was sprinkled through a perforated tin over the potato leaves. The expense, apart from the labour, comes to 3s. per acre, and one man can sprinkle about 2 acres per day. If London purple is not procurable, Paris green is said to be equally effective. Both contain arsenical poison. The leaves, helped by the dew, hold the poison and impart it to the insects, while the latter seem to prefer the poisoned leaves, and die a few hours after eating.

"In writing to the Department on this subject, Messrs. Haywood state that when they commenced applying the London purple and lime the caterpillars had almost destroyed about a quarter of an acre of potato plants, and were attacking, more or less, the remainder of the crop of 4 acres. The effect caused by the mixture was wonderful; in less than 48 hours it was difficult to find a caterpillar alive, and since the application no insects or caterpillars have infested the crop. The leaves show a very healthy appearance, and the part that was first affected is throwing out fresh leaves, promising to produce a fair crop of tubers.

"Messrs. Haywood further say: 'In all probability if we had not applied this poison, our crop, which we can safely estimate at £50, would have been completely destroyed, as others have been in this locality, without any effort to check or destroy by the use of such insecticides as are commonly advised through the *Agricultural Gazette*.'"

Poultry, if allowed access to affected plants, will eat enormous numbers of caterpillars; one duckling (two weeks old) which was watched and timed had in two minutes caught and swallowed 27 of them—it had then been feeding some time, and was left feeding. Fowls, in scratching about, will uncover and devour numerous pupæ, but they are not so useful as ducks.

Cabbage Moth.

All over the world the cabbage, cauliflower, turnip, and many other cultivated and wild cruciferous plants, are attacked by the cabbage moth (*Plutella cruciferarum*). The damage is done by the grubs. These, when full-grown, are somewhat less than half an inch in length, and of a pale-green colour. They eat small holes out of the leaves (usually from the under-side), and are sometimes so numerous that the leaves appear as if threshed by hail. With cabbages, the inner leaves are seldom attacked, although grubs may sometimes be seen in the heart itself. With the cauliflower, sometimes every leaf is attacked, and the crown is frequently covered with excrement and web, becomes of a brown colour, and totally unfit for market. The grubs are very active, and, on being touched or alarmed, move about with convulsive jerks, and frequently drop to the ground by means of a silken thread spun from the mouth. They are attacked by many parasitic and predaceous insects, the small ichneumon fly shown in the woodcut being one of the commonest. These parasites are frequently so numerous that but a small percentage of the grubs eventually turn into moths.

The pupa, or chrysalis, is small, and of a pale-brown colour; it is enclosed in and can be seen through a flimsy silken white cocoon, usually attached to the under-surface of the leaf, and close to one of the ribs.

The moth is grey and white, and when the wings are folded three or four whitish diamond-shaped marks can be seen along the back (so that the insect is sometimes spoken of as the "Diamond-back" moth). The wings are slightly turned up at the tip; when fully expanded they measure rather more than half an inch from tip to tip. The moths are readily attracted to light, and (on account of their attacking many weeds and native plants) may sometimes be seen many miles from cultivation.

Breeding is continuous all the year, although there are more broods in some parts of the world than in others, and in summer than in winter.

Many remedies have been recommended for this pest, as was to be expected, considering its exposed situation and wide distribution.

The late Professor Riley says:—"Every worm visible upon the cabbages may be killed by the use of hot water at the temperature of 120 degrees Fahrenheit. The water may be boiling hot when put in the watering-can, but it will not be too hot when it reaches the cabbage leaves, the thick fleshy nature of which enables them to withstand considerable heat with very little injury. If it is very hot it will colour some of the leaves, but, even where the cabbage is considerably scalded, it will recover, and renew growth from the heart."

Another plan recommended is to boil 1 pound of coal tar in 2 gallons of water, and, when boiling, adding this to 100 gallons of clear water.

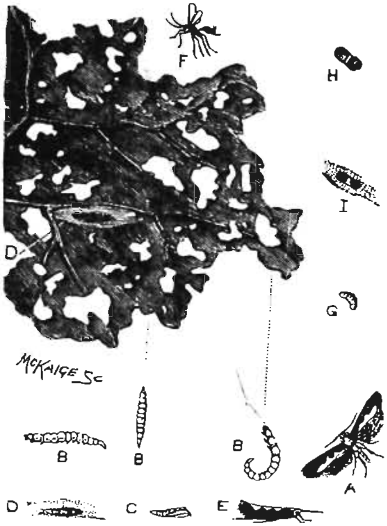
The British Board of Agriculture says:—"From the experiences of 1891, and as the result of many experiments carried out then, dressing the infested plants with soot and lime mixed together appears to be the best remedy. This should be put on by means of a distributing machine, at the rate of from 2 to 6 bushels per acre, the proportions being one part of

lime to three parts of soot. This pungent substance should be distributed with regularity and force over, through, and under the leaves, and upon the bodies of the caterpillars."

The late Mr. A. S. Olliff says:—"All the authorities seem to agree that the best method of lessening the amount of damage from the presence of the caterpillars of this moth is the use of natural or artificial applications, suited to induce a rapid and vigorous growth of the plants. For this purpose nitrate of soda and soot have been recommended."

Hellebore can also be used against these insects, in the proportion of 1 ounce to a gallon of water.

Paris green can also be used on young cabbages, but should not be used after these begin to close over, nor should it be used on other vegetables for at least a fortnight before being cut.



The Cabbage Moth.

A, Moth; B, Grub; C, Pupa; D, Cocoon; E. Moth (side view); F, Parasitic Ichneumon; G, Larvæ of same; H, Cocoon of same; I, Cocoon of Parasite inside of that of the Moth.

Where both the grubs and aphis are present, kerosene emulsion (at the rate of one part of kerosene to 15 of water) can be used with advantage.

It is a mistake, on cutting cabbages and cauliflowers, to leave the stumps in the ground; these simply act as breeding-places for the cabbage moth and other vermin, which more than counterbalance the small profit sometimes obtainable from the sprouts.

Grape-vine Hawk Moth.

The leaves of the grape-vine are occasionally attacked by a very large green caterpillar with a stout long spine over the tail. In Tasmania, so far, it has not been noticed in sufficient numbers to do much damage, and it and its droppings are so conspicuous that, as a rule, hand-picking is all that is necessary. The moth itself (*Chærocampa celerio*) measures about 3 inches across the expanded wings, and is of a light-brown colour, with spots and streaks of silvery scales, and the hind wings marked with pink. It is one of our showiest moths.

COLEOPTERA OR BEETLES.

Some Summer Beetles.

As a rule, our more destructive pests have been introduced, but many of the native insects have taken to cultivated plants, this being especially true of the beetles; probably on account of their being more general feeders, and also of their superiority in numbers over any other order of insects.

Many beetles are to be seen in our orchards and gardens, some of which do not do much damage; but others are becoming rather serious pests, especially in summer. Although they are exposed during the whole time they are feeding, it is very seldom that anything at a reasonable cost can be done against them. It would not, for instance, pay to spray a tree to kill 10 beetles on it, and yet those beetles may destroy, so far as the market is concerned, 30 or 40 apricots or apples, by eating small holes in them. Some kinds appear in immense numbers, strip everything before them, and then disappear. With many, in fact, hand-picking seems all that is practicable.

The Green Beetle.

This is a very beautiful green beetle (*Diphucephala colaspidoides*) about one-third of an inch in length. It may frequently be seen in immense numbers on wattle trees, but it has also developed a taste for fruit trees, and it is not at all uncommon for apple trees to have every leaf stripped by it; it is also very destructive to the raspberry, blackberry, and other small fruits. In Victoria it has been reported as doing serious injury to the cherry, and in New South Wales to the peach; the rose, hawthorn, and other garden plants are also attacked. At the sides of many orchards wattle trees may be seen growing, and when these beetles are in season such trees are frequently the cause of the fruit trees being attacked. The beetles in Tasmania appear in November, and stragglers may be obtained as late as March; they are, however, most numerous during December and January. Every season large numbers can be seen on the flowers of the prickly box (*Bursaria spinosa*), and of the different kinds of tea-trees (*Leptospermum*).

Occasionally the beetles occur in immense swarms, passing in clouds that darken the air, and several instances have been recorded where portions of such swarms have settled down in orchards, when they stripped every leaf from the trees. When they occur in the vicinity of sea-beaches, frequently immense numbers are swept up by the tides. Mr. George Masters states that at Bellerive many years ago the beach was so

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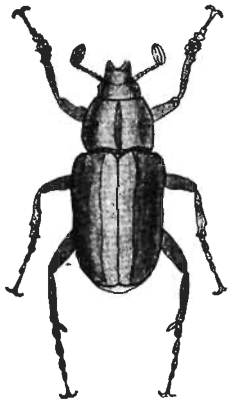
densely covered by these beetles that cartloads could have been taken up. Mr. C. French speaks of "their dead bodies being strewn over miles in area."

Mr. H. M. Nicholls, of Garden Island Creek, writes of them:—

"We had a visitation of the green beetles while I was in town, but they did not touch the apple trees. My brother informs me that for a quarter of a mile in length, and many yards in width, the scrub was literally bending down with masses of them, and it would have been easy to get many bushels of them. I saw the remains of the swarm when I returned, and there were then millions of beetles, though clouds of them had flown away. This is a serious pest down here, and very great damage is done. When the beetles light on the apple trees, they eat the outer covering of the leaf, until they skeletonise it. They come in swarms, always from the north-east, and fly away towards the south-west, and



The Green Beetle *(Diphucephala colaspidoides)*, enlarged.

appear with the greatest regularity every four years, which probably represents the period the insect passes in its larval stages. They appear to prefer plum trees to apples."

Although green is the usual colour of this beetle, specimens are sometimes seen of a pretty blue or even deep purple; occasionally also the head and thorax have a coppery gloss.

The larvæ are of the usual cockchafer type, that is to say, thick, whitish grubs curled up in a semicircle, and with the head brown. When full-grown they are rather more than one-third of an inch in length. They are supposed to pass three or four years underground, but the full life-history has not been worked out, and it is quite possible that they pass but one season underground. One thing, however, is certain, and that is that they sometimes occur in such immense numbers as to do considerable damage to the roots of grass, in this respect being (amongst the cockchafers) second only in importance to the common brown *Scitala languida*.

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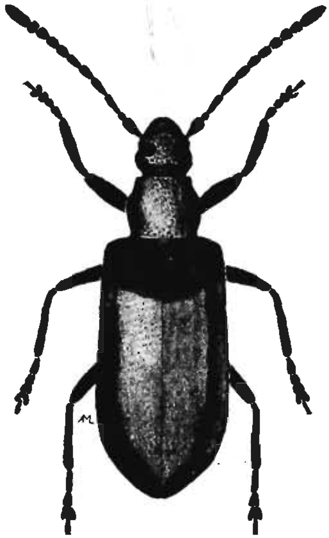
Where the beetles are attacking fruit trees it will be found that by shaking the branches over an umbrella or sheet during the evening or early morning great numbers of them can be obtained. They can also be destroyed by spraying the affected trees with Paris green or some other arsenical poison, but as they usually attack trees in patches, it will seldom be necessary to spray the whole orchard.

A Fruit-eating Beetle.

Ripe fruit is often attacked by a beetle known as *Lagria grandis*. This beetle is about half an inch in length, and of a pale-brown colour, with black legs and antennæ; parts of the

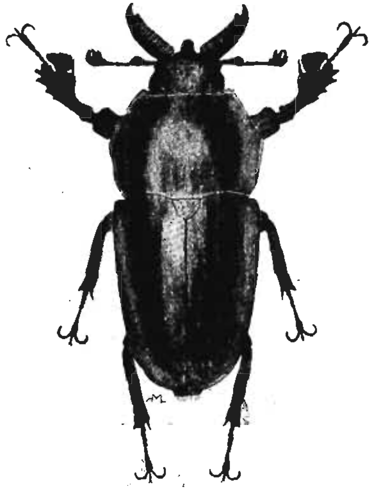


Lagria grandis (enlarged).

body and of the elytra (or wing cases) are also sometimes black. Apricots, pears, and the softer varieties of apples are attacked, and have small holes (much like those made by earwigs) eaten in them, and these holes are often enlarged by earwigs. Singularly enough, this beetle also frequently eats small patches of black spot on growing apples, but the small amount of good it does in this way is more than counterbalanced by the harm it does. Practically nothing can be done against the beetles, except hand-picking, as the fruits are attacked at times when it is inadvisable to use sprays of any kind. The species occurs in all the States except Western Australia.

The Golden Stag-Beetle.

One of our showiest insects is a stag-beetle known as *Lamprima aurata*. The male is about an inch in length, and of a beautiful golden or golden-green colour, and with prominent jaws; the female is smaller, less highly coloured, and with smaller jaws. Specimens may occasionally be seen eating the



Lamprima aurata (enlarged).

leaves of the apple, cherry, and other fruit trees. In its native state, however, it feeds on young gum leaves, and its larvæ feed on old rotting wood. The species is confined to Eastern Australia and Tasmania.

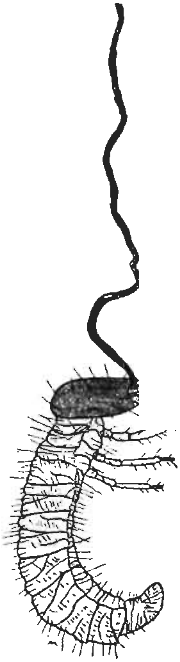
The Brown Cockchafer.

This is a small beetle (*Scitala languida*) about half an inch in length, and of sooty-brown colour, but paler on the lower than the upper surface. It is somewhat variable in colour, being sometimes more of a reddish-brown, and often with more or less distinct blackish stripes on the wing-cases. It occurs in all the Australian States except Western Australia.

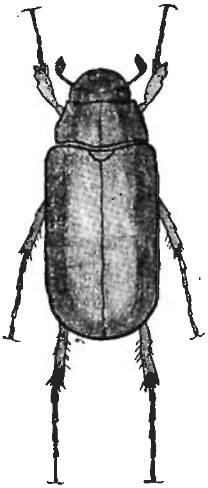
It flies at dusk and night time, and may sometimes be seen in swarms flying around and settling on young gum-trees, of the young and juicy leaves of which it is very fond, so much so that for miles trees may be seen that have had all their young shoots eaten bare of leaves. It may often be seen eating the leaves of the hawthorn, cherry, plum, apple, and pear, usually the top leaves. During the day it may sometimes be taken under loose bark. Owing to its nocturnal habits it is frequently overlooked, although the damage it does to fruit trees is sometimes considerable. The larvæ, which appear to live but one season, are very destructive to grass, and, in Tasmania,

are more destructive than the larvæ of any other cockchafer, or probably all others put together. They eat the roots so that the tops wither and die off, sometimes acres of grass being destroyed by them.

Where the roots have been eaten off, and the grass blows away, leaving the ground perfectly bare, cockchafer larvæ may be suspected as being at work. These, passing their entire larval and pupal stages underground, are frequently overlooked, and the damage they commit blamed to the underground grass grub or other pests.



Parasitised Larva of the Brown Cockchafer (enlarged).



The Brown Cockchafer (enlarged).

Cockchafer larvæ are whitish in colour, and with a brown head; owing to the thinness of their skin the food and earth they have swallowed can be distinctly seen at the hind part of their body. They are always strongly curled up and wrinkled, and frequently roll out into the furrows whilst ploughing is going on. In many parts of Australia and elsewhere in the world their larvæ are of large size, and do an immense amount of damage. In Tasmania they are usually small (seldom exceeding two-thirds of an inch in length), but are still capable of doing very considerable damage.

In many parts of Tasmania cockchafer larvæ and the underground grass grubs may be seen together, but whilst (no matter

how numerous they are) the latter are by themselves, a mass of roots can be found in the ground (although the surface may be perfectly bare); where the cockchafer larvæ are abundant not only is the surface of the ground bare, but no roots are to be seen underground.

The reason for this state of things is evident: the underground grass grubs feed only on those parts of grass appearing above ground, so that (whilst entire death of the grass may sometimes result from their attacks) if the season be at all favourable the grass is not entirely destroyed. But where the cockchafer larvæ are at all numerous, the grass is killed outright, owing to the roots (and the roots only) being eaten. Though smaller in size than the former, they are, therefore, individually far more destructive.

At Stonor, frequently from 30 to 40 cockchafer larvæ could be taken from a lump of earth weighing 10 lbs. or less. The pupæ were very numerous towards the end of November. They usually have the larval skin attached to the tail.

Fortunately, these larvæ are severely parasitised by a species of *Cordyceps*.* This parasitic fungus has a very thin and crooked stem, and proceeds from the head of the larva to the surface of the ground. The writer has never seen it above the ground, owing to the fact that it is kept constantly eaten down by other insects (probably by cutworms and the underground grass grubs).

The larvæ may often be seen dead in oval or elliptical chambers, which they have formed preparatory to changing to pupæ. In such cases, in addition to the *Cordyceps* springing from the head, there is usually to be seen a mycelial thread from 3 to 6 inches in length wound loosely and irregularly round them. This thread is apparently loose, and looks like a piece of frayed cotton.

Even in very dry ground at Stonor a very large proportion of the cockchafer larvæ were destroyed. In one paddock, out of many thousands, fully 19 out of every 20 were so destroyed. No pupæ were seen to be affected, although the pupæ of many cockchafers are known to be attacked by different species of *Cordyceps*.

The figure of the grub was drawn from a specimen that was killed and somewhat distorted by the fungus. The head of this fungus appears to be a favourite food with certain insects, so that although the stems of thousands were seen, not one head could be obtained for illustration.

Plant-attacking Weevils.

All over the world fruit trees are attacked by the members of a large group of beetles, known as weevils; some of these attack the roots, others the trunk or limbs, others the young buds or leaves, and some the fruit. In most instances the damage is done by the adult insects, but in the larval stages some species are very destructive to the roots or limbs of fruit-trees. Some of them are to be seen feeding during the day-time, but the majority of them feed at night, during the day remaining concealed in the earth at the roots of the trees, or under stones, logs, &c. They are seldom to be seen in large numbers, but still many of them are capable of doing considerable harm. Not infrequently,

* Mr. Rodway thinks that this parasitic fungus is probably a new species.

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one specimen of a bud-eating species will destroy 20 or 30 buds in a night. One species (*Leptops hopei*) is very destructive to the apple and grape vine in Victoria and New South Wales, but so far has not been recorded from Tasmania.

Weevils can readily be distinguished from other beetles by the head being supplied with a more or less long snout or rostrum, causing them to be frequently known as "elephant" beetles. They are invariably very hard, and are usually of a dingy-brown or grey colour; this being due to the scales with which they are clothed. The name weevil, however, is commonly applied to many other beetles, such as those seen attacking grains and meals, dried skins, &c.

The Genus *Orthorrhinus*.

One widely-distributed genus of weevils (*Orthorrhinus*) in Australasia contains a number of species, most of which are very destructive to the bark and buds of fruit-trees. They are all winged, and fly at night, during the day remaining concealed beneath, or in the rough crevices of bark, or in similar situations. Their larvæ feed in dead and dying wood, and

Orthorrhinus cylindirostris (enlarged).

probably half of the larvæ seen in firewood belong to members of this genus; occasionally, however, they attack perfectly sound trees. They have been noted as seriously injuring the orange, apple, peach, apricot, and grape vine. The beetles themselves attack all of these, and many other cultivated plants as well, usually by destroying the buds and eating numerous small patches of the bark. In summer and autumn they may often be seen in thousands on newly-felled trees (especially gums and wattles) at night-time. Three kinds are especially abundant, and occur in all the Australian States and Tasmania; these are *O. cylindirostris*, *O. klugii*, and *O. æthiops*.

Orthorrhinus cylindirostris is, perhaps, the commonest and most widely-distributed of all our weevils. It occurs, also, in New Guinea, and many of the islands as well, and it has several fairly-constant geographical varieties. It is a variable

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insect, ranging from one-third to nearly an inch in length; and densely covered with scales, mostly brown, but varying almost to white and to black, but always forming at least six more or less distinct bundles (fascicles)—four on the elytra (or wing cases), and two slightly overhanging the head.

Orthorrhinus klugii, in general appearance, is much like the preceding, but differs in being smaller (it is about one-quarter of an inch in length), more robust, and with different clothing. There is always a large patch of pale scales at the base of the prothorax, and several large patches of similar scales on the elytra; the scutellum appears like a minute white spot, owing to its clothing, and the bundles or fascicles of scales are also more numerous. It is a very prettily-marked insect, and is much less variable than the other species. In some seasons it has been recorded as doing a great amount of damage to the grape vine in Victoria and New South Wales. In Tasmania, so far, it has only been noticed eating the bark and young buds of apple trees.

Orthorrhinus æthiops is very different in general appearance to the two preceding, being without the bundles of scales so conspicuous in those species; its general clothing, also, is much darker, and its shape is more tapering at the ends. In size it is usually slightly smaller than *klugii*. Almost any night in the year specimens of it may be taken on fence-tops about Hobart; but during sultry nights in the summer thousands may be so taken.

Desiantha maculata.

This is a small, blackish weevil, scarcely one-fourth of an inch in length, and covered with greyish scales, many of which are combined in places to form feeble spots. It occurs in all the Australian States, and on many of the adjacent islands. It feeds on an immense variety of plants, and attacks many fruit trees, but especially the apple; sometimes hundreds of specimens may be obtained from beneath one tree. During the day it is seldom to be seen feeding, but it may be taken in earth, under stones, &c. At dusk it comes out to feed, and before taking to flight it may frequently be taken on fence-tops. On the apple it appears to confine its attacks to the young buds and bark, and not infrequently twigs are killed by it. It is a rather serious pest to the grape vine in some parts of Australia, and has been seen injuring wheat.

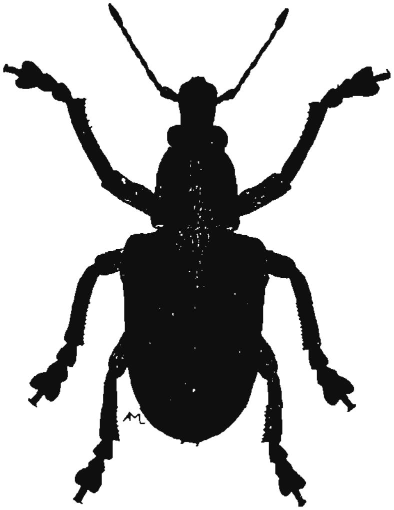
Poropterus antiquus.

This is a dingy-brown or greyish, and rather narrow, weevil, not quite half an inch in length, and which in some parts of Tasmania (to which State it is confined) does considerable damage to the bark and buds of apple trees, especially when they are growing close to heavily-timbered gullies. It belongs to a group of weevils (the *Cryptorhynchides*), all of which, when at rest, have the rostrum and the greater part of the head invisible from above. In its larval state, it is very common in dead and dying sassafras trees.

The Genus *Gonipterus.*

The insects of this genus are hard, brownish, or rusty-looking weevils, usually slightly less than half an inch in length. They are often to be seen on the leaves of young gum trees, or feeding on the bark of the tender shoots. The figure herewith

will give an idea of the genus, the species (*Gonipterus scutellatus*) being one that, in Tasmania, may often be seen eating the leaves and tender bark of apple trees, and not infrequently

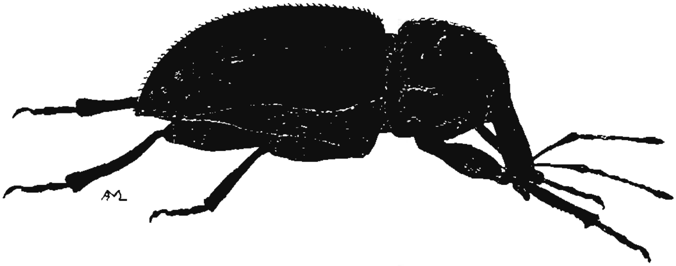


Gonipterus scutellatus (enlarged).

eating small holes in the apple itself. When disturbed, it either drops to the ground, where it feigns death, or else it clings to a leaf or twig with such strength that it will often not let go till one or more of its legs have been broken. On many occasions it has been seen clinging to the stems of apples after these have been packed in cases.

Perperus malevolens.

One of the most annoying weevils in certain parts of Tasmania is a small species known as *Perperus malevolens.*



Perperus malevolens (enlarged).

Throughout the warmer months of the year it may be seen in abundance on several kinds of tea-tree (*Leptospermum*);

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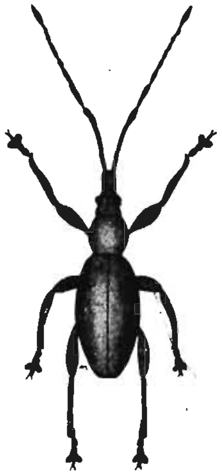
but, on newly-cleared ground especially, it often attacks and destroys the buds of young apricot and apple trees, in consequence of which the trees are often seriously checked, and occasionally are killed outright. As a rule, old trees, or young trees on long-cleared land, are not attacked by these weevils, which, being wingless, cannot fly.

When young trees are starting growth in the spring they should occasionally be examined for this and similar pests; and if any damaged buds are seen, the culprits responsible for the same can generally be found at the roots by disturbing the soil.

Perperus malevolens varies in length from one quarter to one-third of an inch, and is black, but densely clothed with greyish scales, often variegated with white; the antennæ and parts of the leg are of a dingy-red. So far, it is only known to occur in Tasmania.

Merimnetes oblongus.

This is a very small greyish weevil, usually about one-quarter of an inch in length, and rather thin. In its native state it



Merimnetes oblongus (enlarged).

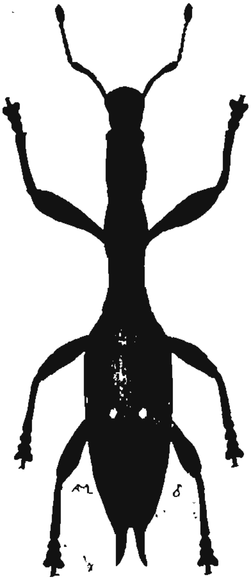
feeds on many of our native trees and shrubs, but especially on the wattles. Being wingless, it is seldom seen far from forests. It may frequently be seen on apple trees, where it feeds on the buds and tender young leaves; so that the leaves, when fully expanded, appear to have been riddled by shot, in much the same way as is caused by the shot-hole disease of the apricot.

Rhadinosomus lacordairei.

In Tasmania, a weevil, which probably does more damage to the strawberry than any other insect is *Rhadinosomus lacordairei*. This is a very narrow brown insect, about half an inch in length, with two or four small whitish spots about the middle. Its grubs are legless, about one-third of an inch in

length, white with a yellowish head, and slightly curled up. They live in the stem of the strawberry, through which they tunnel small passages, which become filled with small brown pellets (their excrement). They often make their way to the crown, and may sometimes be seen drilling inside one of the stouter leaves. As many as three of the grubs have been seen inside one plant. The chrysalis is of a pearly-white colour, and of a rather peculiar shape.

The attacked plants grow weaker and weaker, do not produce berries as they ought, and the leaves get smaller; the plants in time dying. Practically nothing can be done against this and similar insects, except gathering up and burning the sickly plants.



Rhadinosomus lacordairei (enlarged).

This weevil occurs in all the Australian States, and a closely-allied, if not identical, species occurs in New Zealand. In its native state it feeds on the leaves and tender bark of the eucalypti.

Rhinaria perdix.

In some seasons and districts one of the most troublesome pests of the strawberry is a small weevil known under the above name. It is known only from Victoria and Tasmania. It measures one-fourth of an inch in length. The weevils themselves do comparatively little harm, although they feed (at night time) on the fruit and flowers, but especially on the buds; it is their larvæ that do the most. These are whitish, slightly curled, legless grubs, with the head yellowish, and the

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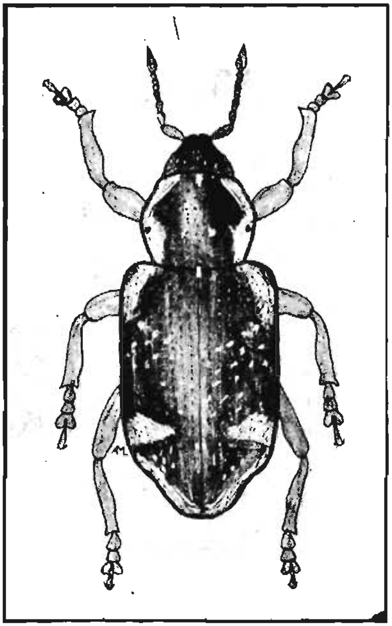
tips of the jaws black; there are also two small ocelli (eye spots) on each side of the head. Frequently the grubs eat the inside parts of the stems, and it is not at all uncommon to see three or four tunnels made in one of these; the tunnels frequently end in the crown itself, or near the crown. The stems of the larger leaves and berries are also bored.

When the stem is gnawed partly through low down, the plant is sometimes killed, but it frequently throws out roots above the attacked parts, and the plant survives; but always when the crown (or parts near the crown) is attacked, the plant is



Native Strawberry Weevil *(Rhinaria perdix)*, enlarged.

destroyed, the leaves wither, and a sort of brown collar rot sets in. Sometimes also the leaves (being gnawed through at their bases) fall off.

As a rule not much damage is done (or at least noticed) until the plants are at least two years of age, but after this they frequently become seriously attacked.

An Introduced Weevil.

Another weevil (*Otiorhynchus sulcatus*) is a well-known European pest, and has become firmly established in Australia, Tasmania, and New Zealand (and, probably, elsewhere). Its

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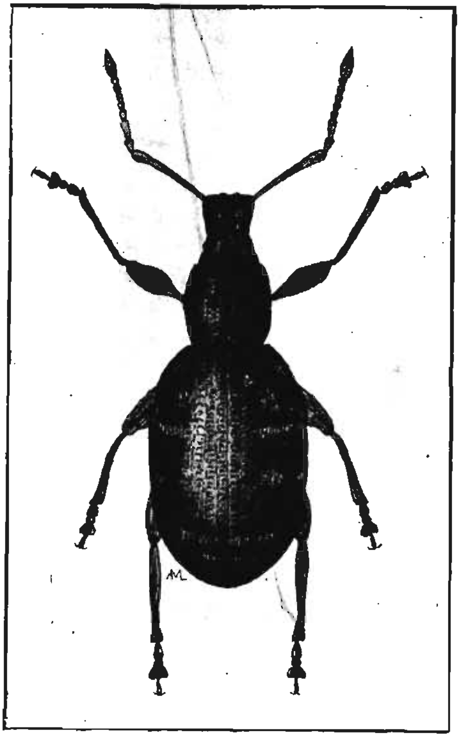
methods of attacking the strawberry are much the same as that of the *Rhinaria*. It is, however, a rather larger insect, of a deep black colour, with small obscure spots of yellowish scales. It has no wings, and, therefore, cannot fly, so is usually only seen in places that have long been cultivated. The *Rhinaria*, however, has ample wings, and so is sometimes seen in places far distant from the older settled districts. The grubs of both are much alike, but that of the *Otiorhynchus* is stouter, and has longer, more numerous, and darker hairs. On the grub of the *Rhinaria* the hairs are very few in number, and very short,



Introduced Strawberry Weevil (*Otiorhynchus sulcatus*), enlarged.

so that they can only be seen with the aid of a magnifying glass.

Besides the strawberry, the *Otiorhynchus* has been reported as destructive to the raspberry, gooseberry, apple, hop, peas, and beans, and many other fruits, vegetables, and garden plants. When setting out the plants, it will be found that they will be proof for some time against the attacks of these weevils, if a small quantity of waste tobacco or hellebore is placed in the hole with them; with standard plants, also,

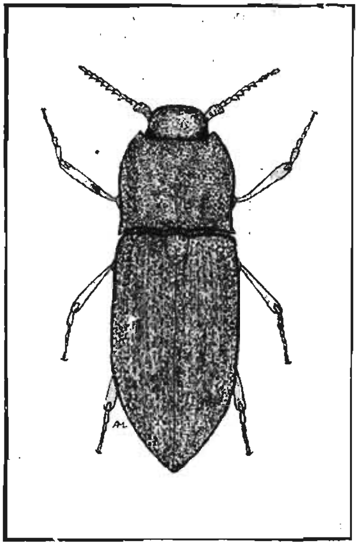
both of these substances are useful, and while they last no eggs will be laid. It will probably also be found that the common tansy, if dried, ground up, and placed at the roots, wi protect these for some time. But once the plants show that they are attacked, it will be found best to pull them up and burn them, as such as are not killed outright are always sickly and produce but a small quantity of small and weedy berries. Simply pulling up and throwing the affected plants in a heap is not sufficient, as the grubs can obtain sufficient nourishment in the stems to develop into weevils. Tar water has been recommended to prevent the eggs from being laid, but, of course, it should not be used whilst the berries are ripening.

For similar pests to these it was at one time thought that artificial manures might be of use, but experiments that were carried out demonstrated that the quantity required was so great that all plant life was destroyed, and that the cost in any case was prohibitive.

Miscellaneous Beetles.

Wireworms.

In Tasmania, millipedes are usually called wireworms; but true wireworms are narrow pale-yellowish rigid larvæ, with six



A Click Beetle (enlarged).

small legs near the head, whilst millipedes (except when very young) always have many legs, moreover, a millipede never considerably alters its form, whilst true wireworms eventually develop into beetles commonly called "click" beetles or

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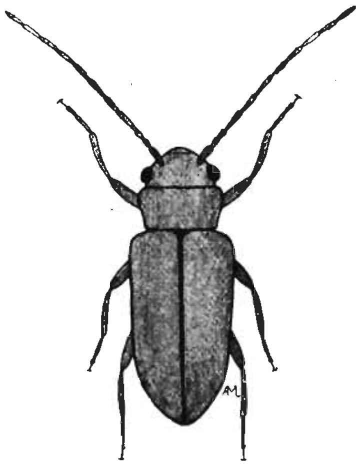
"crack-backs," owing to their habit of springing up with a jerk when placed on their backs. The click beetle here shown (*Lacon caliginosus*) is common all over Eastern Australia and Tasmania, and its larvæ feed on the roots of grass and weeds, and sometimes are rather destructive to the strawberry. It may often be seen in codlin moth bandages and under the loose bark of eucalyptus trees; also in holes of fallen apples. Wireworms, in some parts of the world, are reported as doing immense damage to wheat, oats, turnips, and other crops; but no serious outbreak in Tasmania has been yet reported, although we have many species of them, especially of the genera *Lacon* and *Monocrepidius*.

A Small Leaf-eating Beetle.

In spring a very small beetle, known as *Monolepta subsuturalis*, attacks the young leaf buds of the apple, and eats small holes in them. On the buds opening the young leaves



Monolepta subsuturalis (enlarged).

appear much as if a charge of shot had been fired through them. The beetle itself is about one-sixth of an inch in length, of a pale-yellowish colour, with a narrow black stripe along the middle. It attacks fruit trees as a rule only when they are growing close to the bush. Two similar beetles, *Monolepta rosea* and *Aulacophora hilaris*, do an enormous amount of damage to fruit trees and other plants in Australia.

Blue Hopping Beetle.

A small deep-blue hopping beetle, known as *Haltica pagana*, occasionally attacks strawberries, but apparently only when these are growing close to a kind of burr, upon which the beetles usually feed. But when they do attack the strawberry, they appear in such numbers that the plants are sometimes killed outright. The larvæ are black, and also attack the

leaves. Both the beetles and their larvæ, however, can be readily destroyed by spraying with hellebore at the strength of 1 ounce to 1 gallon of water, and this can be applied at any time without injury to the plants sprayed upon.

A Longicorn Beetle.

In addition to the cherry-borer, the hazel nut tree is attacked by a longicorn beetle known as *Uracanthus pallens*. The larvæ of this beetle are of a creamy-white colour, and bore into the limbs and trunk of the tree. When nearly full-fed they gnaw out a kind of chamber in the limb attacked, and the limb in consequence is nearly always snapped off with the first strong wind.

Small Boring Beetles.

Dead and dying fruit trees are often attacked by small boring beetles belonging to the families *Bostrychidæ* and *Scolytidæ*; healthy trees are also sometimes attacked, and especially when these are near dying trees. The holes the beetles make are very small and perfectly round, so that they are sometimes known as shot-hole borers. The beetles themselves are all small, usually measuring one-fourth of an inch in length, or less; they are all of a yellowish or brown colour, and more or less cylindrical in shape. The commoner sorts in Tasmania are *Platypus omnivorus*, *Xyleborus compressus*, *Tomicus truncatus*, *Xylopsocus bispinosus*, and *Xylion collaris*.

In fences, numerous small holes may often be seen; many of these have been made by the abovenamed beetles, but fences are also often attacked by other small beetles which never attack green wood. The principal ones of these are *Lyctus brunneus* and *L. canaliculatus*, both of which have been introduced to Tasmania, probably in furniture or in various kinds of soft woods. They are often very destructive to furniture and to hop-poles.

HOMOPTERA OR SCALE INSECTS, APHIDES, &c.

Scale Insects.

Of all the pests attacking fruit trees in Tasmania, there are none in which the life histories are so singular as with scale insects. These insects derive their name from the fact that a great many of the species appear like small scaly excrescences on the leaves, bark, or fruit of various plants. The family may be roughly divided into three sections, the first consisting of species which retain their legs during the whole of their life, the second consisting of species in which the legs are lost by one sex and scaly coverings (entirely separated from the insects but serving to protect them) are formed, and the third in which the legs may or may not be lost, and which live within woody excrescences they cause to grow upon the stems or leaves of the plants attacked. To the first section belong the mealy bugs, cochineal insects, and the cottony cushion scale; the latter was accidentally introduced to California and elsewhere, and did enormous damage before it was kept in check by the introduction of its natural enemies. The cochineal insect is one of the very few useful insects of the

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group; the mealy bugs are nearly all destructive. To this section also belong the "paradise" flies, a group of insects of which the males are very beautiful, with two fine wings, bright red eyes, and long tails of shining, glassy filaments. The females are much larger, of a dark-brown colour, and without wings and tail. In fact, in the whole of the family the females are always wingless, and the males winged, when full-grown; with some of the species the males vastly exceed the females in number, whilst in others the males have never been seen. In the second section many of the accepted definitions of insects do not hold good, for the larva is frequently of more perfect shape and with more senses than the adult insect. The section contains more species than the others combined, and the members of it are known as "armoured" scales, one of them being the mussel scale, only too-well known to Tasmanian orchardists. The species of the third or gall-forming section have their headquarters in Australia, and all of them are highly remarkable. By puncturing the leaves or stems of trees they cause peculiar woody growths or "galls" to form, and these growths are constant in appearance. The insects within the galls are often of most remarkable forms; but as yet they all confine their attacks to our native plants.

There are many species of all three sections in Tasmania, but the only two which can be regarded as serious pests to the plants attacked by them (in Tasmania) are the gooseberry scale (belonging to the first section) and the mussel scale (belonging to the second section).

Mussel Scale.

This insect (*Mytilaspis pomorum*), after the codlin moth and black spot, is the most serious pest of the apple in Tasmania. The insect itself, when full grown, is small and legless, and remains attached to the trunk (or other parts of the tree attacked) by its rostrum, and is protected by a scaly covering. This covering is brown and curved, being something like a carraway seed in general appearance. The insects themselves are small, but as they occur in immense numbers will sometimes cause serious injuries to the trees attacked, or will even entirely destroy them. The fruit (especially the apple) is often attacked, and, besides being sometimes greatly reduced in size, is also so much disfigured as to render it of much less value when sold, and also (when sent to ports on the mainland) being liable to be condemned.

This scale insect, more than any other in Tasmania, seems to have periods of especial abundance, when in some districts it becomes so bad as to be almost or quite as troublesome as black spot. These periods may last for several years, when some disease frequently appears to attack the scale, and causes it to die off. This disease, although exceedingly useful where it does appear, is not to be relied upon, and in nearly every instance where the scale appears, it will be found advisable to take remedial measures against it. In an orchard at Premaydena, during 1902, a scale-eating grub appeared,

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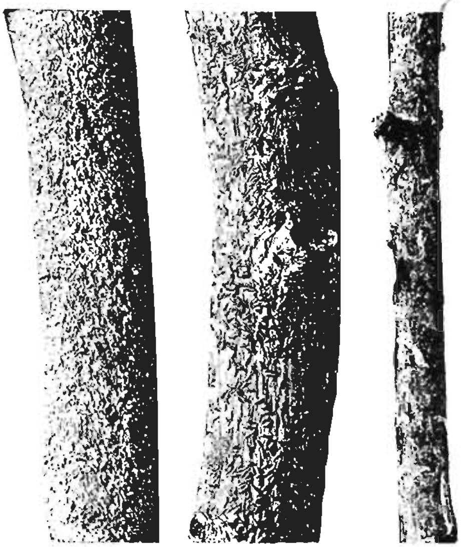
and, forming a net-like mass of webbing amongst the scales, almost freed the tree from them. A twig on which these insects had been at work was carefully examined, and it was seen that over 90 per cent. of the scales had been destroyed. Where the scales had been densely massed together, every one had been eaten, but where they were scattered singly a small number escaped. Some of these grubs, kept in a breeding cage, eventually developed into moths known as *Batrachedra sparsella*, a species known to feed on many of the armoured scales all over Australia. Many ladybird beetles feed on the scales, the most useful one in Tasmania probably being *Orcus australasiæ* (a blue insect with 6 or 8 yellow spots). In Tasmania (and also on the mainland) there is a very common and widely distributed species of mussel scale which attacks the wattles, gums, and several other trees, and is frequently considered to be the same as the apple mussel scale. This scale, much as it resembles the one of the apple, is never known to attack cultivated fruits. Comparing the two together, it can be seen that the wattle scale is slightly larger, more convex, and paler, and when densely massed on the limbs it has a looser appearance than the apple scale when so massed. The mussel scale of the apple, however, is known to attack (besides the apple) the pear, cherry, quince, plum, hawthorn, and, very rarely, and to but a slight extent, the peach. It is to the apple that the principal damage is done, although in some instances the pear and cherry are badly attacked.



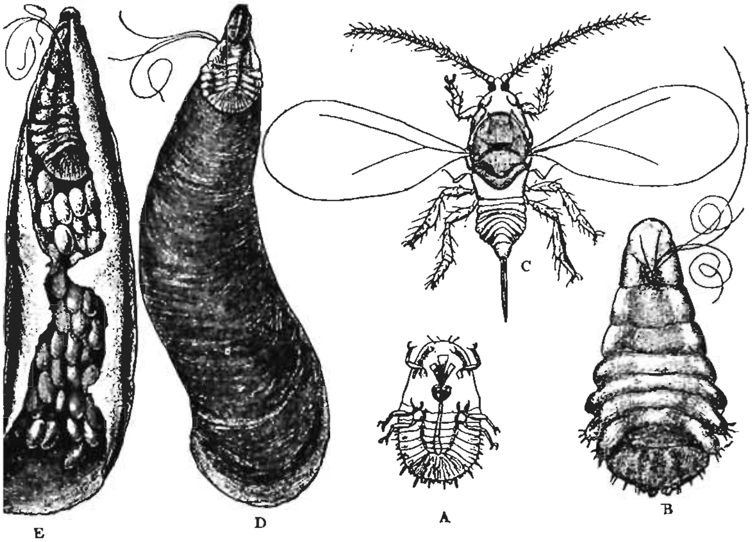
On the left, Mussel Scale of Wattle; in the middle, Scale of Apple; on the right, the same, attacked by larvæ of *Batrachedra*.

The mussel scale does not seem to thrive in the warmer parts of Australia; but the climate of Tasmania and the cooler parts of New South Wales and Victoria suit it to perfection.

The mussel scale is reproduced by eggs; these, in Tasmania, hatch out from late October to December, according to districts and seasons. The larvæ, when first hatched out, are minute six-legged creatures of a pale-yellow colour, possessing eyes and antennæ. In this stage the sexes cannot be distinguished. After scurrying over the plant attacked (usually the apple) in search of a suitable place to settle, one is selected,

and the larva inserts its rostrum into the bark or fruit to suck up its juices; it grows rapidly, forming a protecting scale over itself as it develops, and soon completely loses its legs, eyes, and antennæ. The female never regains these, but she retains her rostrum throughout. The male, on the contrary, when full grown leaves his covering scale in possession of two wings, six legs, and a pair of beautiful eyes, but without a rostrum; *his sole purpose in life is to fertilise the female*, after which he dies.

Whilst the larvæ are moving, and when the scale is just being formed, are the periods when this pest can be most readily destroyed: but the tree at this stage is so susceptible to injury that many remedies—perfectly safe to use in the winter—cannot be used in the summer at their full strength. Kerosene emulsion and resin and soda, however, will be found



The Mussel Scale—(A) Newly hatched larva; (B) Female; (C) Male; (D) Scale from above; (E) Scale from below. All greatly enlarged. (From Dept. of Agriculture, Washington.)

very useful at this stage, but they *must* be used twice, the second time about a fortnight after the first.

Should the insects be allowed to mature, a scaly covering is formed, beneath which the females lay their eggs (minute bodies, elliptical in form, and of a pearly lustre); these remain till the following summer, when they hatch out.

Much stronger remedies are required against the eggs than against the young larvæ, and these, as a rule, can only be applied when the trees are bare of leaves.

Mussel scales that have been killed by oil sprays and washes will generally remain on the trees for years after they have

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been treated, and the orchardist often thinks his treatment has not been effective; but in addition to the test of scraping the scales off into the hand, mentioned under oils, it will be noticed with an effective spray that the fruit and young wood are not covered.

Gooseberry Scale.

The gooseberry (also the raspberry and red and black currants to a certain extent) is attacked by the gooseberry scale (*Lecanium ribis*). This is a round, convex, pale-brown insect, about half the size of a grain of wheat, which attaches itself, sometimes in immense numbers, to the branches (and occasionally to the midribs of the leaves), and will always (when present in great numbers) seriously injure them, or even destroy them outright. On lifting the scales early in summer it will be seen that they are full of eggs, which will later on hatch out, to continue the work of destruction.

Any remedy, by spraying against the pest, should be applied in winter (the sulphur, lime, and salt mixture will be found to be very useful), as during the summer the leaves and fruit are so dense that it will not pay to apply ordinary spray materials, on account of the quantity it is necessary to use to get at the bark.

Probably the best and cheapest treatment, however, is to pull out and burn all badly affected plants, or, when pruning, to cut out and burn the branches most thickly covered with the scale.

Other Scale Insects.

Other introduced scale insects which have been recorded from Tasmania are—black scale (*Lecanium oleæ*), ivy scale (*Lec. hesperidum*), San José scale (*Aspidiotus perniciosus*), quince scale (*Asp. cydoniæ*), European scale (*Asp. ostreæformis*), greedy scale (*Asp. rapax*), Ross' scale (*Asp. rossi*), red scale (*Asp. aurantii*), and rose scale (*Diaspis rosæ*).

Aphides or Plant Lice.

Woolly Aphis.

The apple is attacked by two species of aphides: one of these (*Aphis mali*) only attacks the young shoots and leaves (usually the latter), and (in Tasmania, at least) is never very destructive. The other, however, is very destructive to the apple wherever grown. It is known as the woolly aphis or American blight (*Schizoneura lanigera*), and attacks both the branches and roots. These aphides secrete a white woolly substance, which gives them their characteristic appearance; they attack the trunk and limbs wherever these have been wounded, or, failing wounds and scratches, almost any part is attacked, and knots and aborted growths are caused. The roots attacked develop great lumps many times the thickness of ordinary roots, and the trees are considerably injured thereby.

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Root pests are invariably difficult of treatment; but, fortunately, several varieties of apples are known which make excellent blight-proof stocks (the two best known ones are Winter Majetin and Northern Spy). It is, therefore, always advisable, *when setting out an orchard, to* see that the young trees are on blight-proof stocks. It may also be taken for granted that once the roots of an apple tree become badly attacked by the woolly aphis they can never become permanently cured, so that in the case of badly-infested trees it is the best plan to remove them altogether; this is especially the case with trees that are badly attacked before coming into bearing.

Woolly Aphis on Twig.

Various remedies have been tried for the root form of the pest, with more or less success. The best appears to be ground tobacco stalks and other waste tobacco. Mr. J. M. Stedman says of this:—"The root form of the woolly aphis may be cheaply and easily killed and kept away from an apple tree by the liberal use of tobacco dust. About five or six pounds of this substance should be applied to the roots of every infested tree, and one-half this amount should be applied in similar manner each succeeding spring." In the United States tobacco dust can be obtained at a cent. a pound (two pounds for a penny), but, unfortunately, it is too expensive in Tasmania to come into general use, unless home-grown. In the old sheep-dipping days a large quantity of tobacco, locally known as "Knock-me-down," was grown. Tobacco, to be produced to perfection, needs to be grown in thoroughly worked and well-manured or naturally rich land; but as for insect pests any quality will suffice, a few plants set out where they will be protected from frosts will probably produce as much as will be required. Potash is a useful fertiliser for this plant, consequently it grows well on ground that has been recently burned

over. The stalks and seeds, as well as the leaves, can be used, and this coarse kind of tobacco will be found very useful against many kinds of insects. A fair amount of success against the aphis has been obtained by exposing the roots in winter and drenching them with hot (not boiling) water, by drenching them with bluestone at the rate of two ounces to the gallon of water, and by injections of bisulphide of carbon; to use the latter, however, a special machine is required.

The pest, when on the trunk and limbs, can be destroyed by one or two sprayings with strong kerosene emulsion, or with resin and soda, &c. Any spray material used, however, must be applied with considerable force, as the woolly secretion forms a covering to the pest that is impenetrable to ordinary sprays, and it needs to be blown away to allow the spray to come into contact with the aphides themselves, simply spraying lightly on the trees (as for ordinary aphides and scale insects) being of little use. The sprayings should be done after pruning, and when the trees are bare of leaves. Spraying, of course, could be done at other times, but a much greater quantity of material would have to be used.

Woolly Aphis on Rootlet.

Black Peach Aphis.

This introduced pest (*Aphis persicaniger*) has become well established in Australia and Tasmania, and is a troublesome one to deal with. It first appears when the buds are beginning to swell, and attacks these in countless numbers; in consequence, they do not burst, or they may burst and a few sickly leaves grow, but soon turn yellow and drop off.

The aphis is a rather small one, and is of a dark chocolate-brown colour. They pass the winter on the roots of the peach, but the first favourable day in very early spring or late winter will cause them to come out in millions. Not infrequently they will cause the loss of the entire crop, besides severely injuring the trees themselves. Young nursery stocks are often killed.

This aphis, like most of the family of insects to which it belongs, breeds very rapidly, so that there are a number of broods before midsummer; at which time the survivors go underground, and fasten on to the roots.

Root treatment, as for the woolly aphis, is also useful for this pest. Dr. J. B. Smith recommends periodical dressings of kainit. He says:—"This will not only act as an efficient fer-

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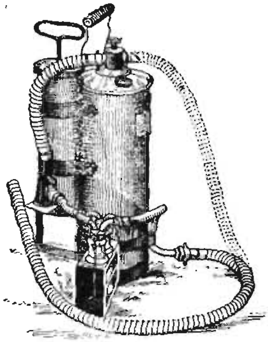

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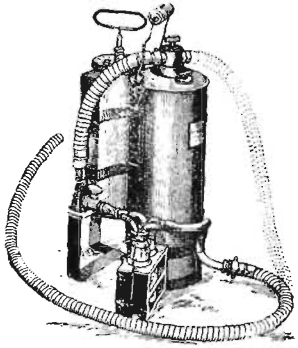

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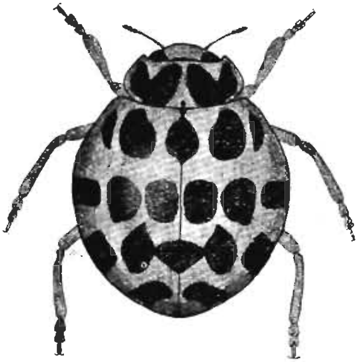
tiliser, but will also serve to destroy many aphides. The application should be made just before a rain if possible, so that the salts can at once be dissolved and carried into the ground. Wherever the solution comes into contact with the aphides it will kill them."

The Green Peach Aphis.

This pest (*Aphis persicæ*) is larger than the black peach aphis, and, as its name implies, is of a greenish colour. It appears later in the season than the black species, and attacks the shoots and leaves. The leaves are frequently blistered, so that they look as if distorted by the peach-curl; in these blisters dozens of the aphis may be seen in its different forms.

A useful spray against both these species is soap and tobacco; kerosene emulsion is also useful. But as a rule, whatever spray is used, it will need to be repeated, as these insects breed so rapidly, that if only a few are missed, in a week or two there will be almost as many as there were before spraying was done.



Ladybird Beetle (*Leis conformis*), enlarged.

A yellow ladybird beetle with black spots (*Leis conformis*) may often be seen feeding on this and other kinds of aphides, and undoubtedly helps to keep them in subjection.

The Cabbage Aphis.

In the summer and autumn this insect (*Aphis brassicæ*) is only too well known on cabbage and turnips (it also attacks swedes, mangolds, and other cruciferous plants). It is of a dull greenish colour, but covered with a greyish mealy substance, which rubs off on the fingers. They usually occur in patches on the leaves, and the earth beneath the plants sometimes appears greyish from the secretions given off by them. When badly attacked the cabbage has a strong and disagreeable smell, which can be noticed many yards away.

Thousands of specimens may often be seen on a single leaf, and reproduction is so rapid that were it not for useful insects that keep them in check, the growing of cabbages and turnips would be almost impossible. The most useful of these parasites is a small ichneumon fly. When attacked by this species, the

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aphides lose their soft downy appearance, and turn to a dark straw colour, and become somewhat shiny; and on examination the hole from which a parasite has escaped may often be seen.

In addition to the ordinary sprays for aphides, hot water (as noted under the little cabbage moth) can be used against this species. It is also as well to force the cabbages on as much as possible, as when growing slowly they are injured to a greater extent than when growing rapidly.

The Potato Aphis.

A species of aphis sometimes attacks growing potatoes so badly as to practically destroy the entire crop, or at least to seriously reduce it in value. The aphides swarm over all parts above ground, cause the leaves to become small and distorted, and prevent the flowers from properly developing. The stems will also often rot, and the tubers themselves do not ripen properly. The aphides can be destroyed by spraying with kerosene emulsions or other oil emulsions; but the spray will need to be repeated at an interval of about 10 days, and should be put on with force and directed from the sides.

When the aphides are bad there may usually be seen flying around them numerous "hover" flies (*Syrphidæ*); these lay eggs on the leaves, and the eggs hatch out in a day or two into maggots, which at once start feeding on the aphides. It is undoubtedly largely owing to these insects that the aphides are often held in check. The eggs of the syrphus flies are pearly-white in colour, long, thin, and finely fluted. The maggots are about a quarter of an inch in length, and taper to one end; when moving they have a peculiar tremulous motion about the thin (head) end.

Other Aphides.

There are many other kinds of aphides in Tasmania, most of which have been introduced. Some are known to attack the pear, plum, cherry, carrot, rose, chrysanthemum, daisy, forget-me-not, marguerite, and many other garden plants. In fact, few plants escape their attacks altogether.

Twig-attacking Insect.

All over the world twigs and branches of trees have slits cut in them by various kinds of insects belonging to the *Cicadidæ*, a group of insects frequently called locusts, but wrongly so, as

Twig showing Work of Cicada (actual size).

locusts, strictly speaking, belong to the *Locustidæ*, a family of grasshoppers. The species of Cicada most in evidence in Tasmania is one now known as *Melampsalta torrida*. This is an insect about three-quarters of an inch in length, and measuring from 2 to 2½ inches across the expanded wings. Tasmanian specimens have the body almost entirely black, but

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on the mainland it is often largely variegated with brown; the wings are glassy-looking, and divided into small areas by "veins," varying from yellow to black.

The males of all the *Cicadidæ* produce sounds varying in intensity with the size of the insects and of their "drums." The "drums" are two hollow vessels, one on each side of the base of the abdomen. The species now being considered makes a peculiar creaking noise that is easily recognised; but the sound made by some of the larger species when in numbers is almost deafening.

In January and February the call of the male may often be heard in our orchards; it is often difficult to locate the insect, but on this being done, he generally keeps on calling till one is within a few feet, then he becomes silent for a little while, and finally takes to flight with a sharp rustling sound.

The female is provided with a saw-like appendage to the abdomen (when at rest, this is concealed), and with this she cuts a slit in a twig, continuing this till from four to eight slits are made; in a short time from 2 to 4 inches of the twig appears scarred with a bundle of fibres obliquely projecting from each slit; if these are cut into it will be seen that they are closely packed with long, narrow yellowish or salmon-coloured eggs. As soon as the larvæ hatch out, they go under-

A Tasmanian Cicada (*Melampsalta torrida*), enlarged.

ground to feed on roots; it is not known how long they remain there, but it is probably for several years.* When full fed they turn into the chrysalis stage, and some time after force their way upwards to the surface, and then crawl up the trunks of trees or fences; here they remain for a little while, and finally the perfect insects emerge from the pupal skins, and these are left on the trees or fences looking somewhat like the skins of prawns.

Probably no kind of fruit tree escapes their attacks, and in the departmental collection are twigs of the apple, pear, plum, peach, black-currant, and gooseberry that have been attacked. Young trees in newly cleared ground are very subject to attack; and this is particularly annoying, as the shape of the tree in consequence will sometimes need alteration from the plan originally devised for it.

* A well-known American species lives for 17 years underground.

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The remedy is simple: when pruning is being done, the affected twigs, which, as a rule, are easily detected, should always be cut out and burnt; if this is not done the twig, when it grows into a branch, is liable to snap off, and the scarred portion is always a favourite place of attack for the woolly aphis.

No spray is known that can be used against it, as it rapidly takes to flight when alarmed, and even if a few drops of the ordinary contact sprays touched it, no injury would result. Arsenical sprays are also useless against it, as it ceases to feed on becoming winged.

Hopping Bug.

A small pale-green hopping bug, about one-eighth of an inch in length, may often be seen on potato plants. It, like the aphides, lives by suction, and leaves may frequently be seen that are covered with whitish specks caused by these insects; unlike the aphides, however, it does not fix itself to one place, but hops about on the least alarm. Potatoes may frequently be seen in which every leaf and some of the smaller stems are speckled, and such a heavy drain on the leaves must result in injury to the tubers. Many garden plants and several weeds are attacked, as well as the potato. The bugs are readily attracted to light, but they are very difficult to kill by spraying, as, living by suction, they cannot be reached by Paris green or other arsenical poisons, and being active, they frequently escape kerosene and other emulsions which kill by contact.

HEMIPTERA OR TRUE BUGS.

There are numerous plant bugs in Tasmania, but, fortunately, few of them are destructive to fruit, as of all insects these are probably the most difficult to combat; contact sprays can seldom be used against them, and arsenical poisons are totally useless. Being winged, they can (and very often do) readily take to flight when sprayed upon, and, as they suck up the juices of the fruit or leaves (instead of nibbling them with jaws), coating these with poisons is quite useless. The most noticeable kinds in Tasmania are the soldier or harlequin bug and the strawberry bug.

The Soldier Bug.

The soldier bug (*Dindymus versicolor*, a prettily variegated insect about half an inch in length, its principal colours being yellow, brown, and black with the abdomen green) is sometimes destructive to small fruits (especially the raspberry, red currant, and gooseberry), and occasionally attacks the apple. With the raspberry, each part of a berry attacked is sucked dry, so that the whole berry has a very unattractive appearance. Fallen apples are frequently attacked, but when on the tree, and especially when hard and green, they are seldom attacked. They may often be seen clustered in immense numbers on fences, when they can, of course, be destroyed with boiling water; kerosene can also be used against them, a small quantity of the oil readily destroying large numbers. This

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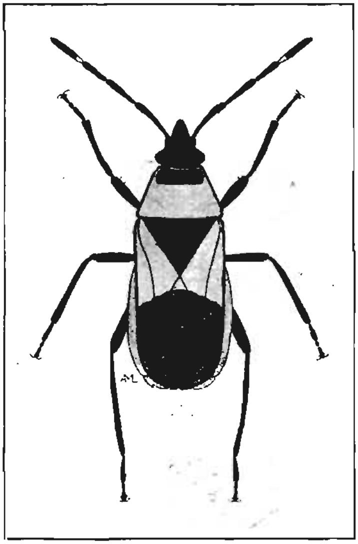
bug also eats other insects, especially grasshoppers and earwigs; it feeds principally at night time. It appears to be very fond



The Soldier Bug (enlarged).

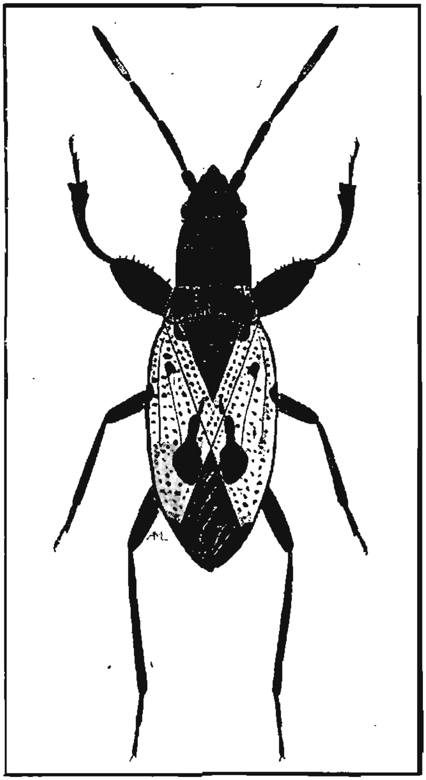
of the seeds of many kinds of weeds, and especially of the milk thistle.

The Strawberry Bug.

The strawberry bug is a narrow black and grey insect, about one-third of an inch in length, and belongs to the *Lygæidæ* (the same family to which the American "chinch" bug, and so many other destructive bugs belong). It is very common in New South Wales, Victoria, and Tasmania, and feeds on the juices of many berries and succulent plants. Specimens are most numerous in December and January, but may be obtained all the year round. In the winter many may be found hibernating in all stages in rotten wood. On the strawberry they appear to confine themselves to the berries, and, owing to their attacks, these frequently become distorted, and, when ripe, often have greenish patches on them, greatly lowering their appearance. As many as twenty or thirty may sometimes be seen on one berry, so that the berry itself is often almost hidden. The bugs cannot be hand-picked, however, as they are exceedingly active, and scurry off as soon as one comes near them. They can fly, but do not do so very readily. Hundreds may often be seen round one cluster of plants, hiding beneath the leaves and straw, and doubtless many could be destroyed by gathering up and burning the straw. The great difficulty with these insects is that they only attack the berries after these are well formed, so that no spray seems possible against them, as any of an oily nature would also injure the berries, whilst if not of an oily nature, the small

quantity which would touch the bugs could be easily thrown off. Possibly some substance will be found that, placed beneath the berries, will not injure them, and at the same time be offensive to the bug, but at present no such substance appears to be known.

When many of these bugs have been feeding on a berry, the berry itself often becomes tainted with a disagreeable flavour. These insects are often seen on the gooseberry and raspberry as well. They are eaten by several other kinds of insects (principally ground beetles) and sometimes by starlings and other birds.



The Strawberry Bug (enlarged).

The Rutherglen Bug.

Another bug which may yet be troublesome to Tasmanian orchardists and farmers is the Rutherglen or Australian chinch bug (*Nysius vinitor*), a very small active kind, which feeds on

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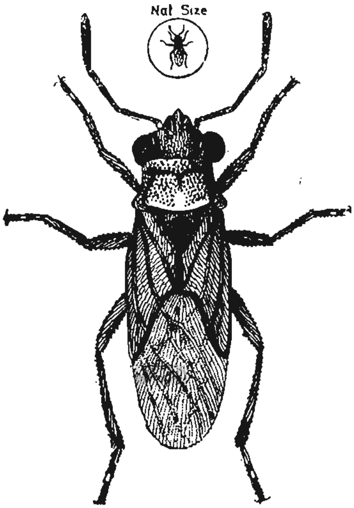
grasses and small shrubs, as a rule, but which has often been seen attacking wheat and other cereals, the potato, tomato, and many garden plants. In Victoria and New South Wales



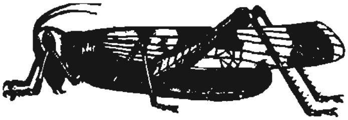
The Rutherglen Bug (enlarged).

it has been reported as troublesome to the cherry and potato: in Tasmania it has been seen attacking the raspberry.

ORTHOPTERA OR GRASSHOPPERS, CRICKETS, EARWIGS, &c.

Grasshoppers or Locusts.

In Australasia there are numerous kinds of grasshoppers, some of which are destructive only in open plains or sparsely-timbered country; others only when in forests. Occasionally the plague locust will ravage hundreds of miles of country and become a serious pest. But in Tasmania the plague locust is seldom very troublesome. In some years, in New South Wales and Victoria, it has caused the loss of thousands of head of stock.



The Plague Locust.

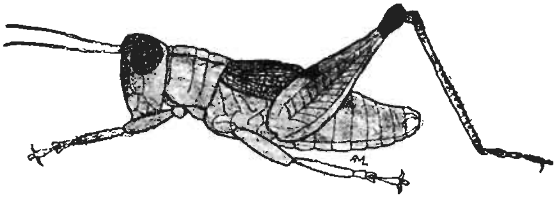
The Wingless Grasshopper.

During some seasons grasshoppers, especially a small wingless species,* are very destructive to fruit trees. The species figured is wingless during its whole lifetime (an allied species, sometimes seen in company with it, has wings). As a rule it lives in companies, and these move about from place to place

* Mr. J. G. Otto Tepper says this is a species of *Goniæa.*

as their food becomes exhausted. At night-time they will often seek shelter in briars, thistles, rushes, and tussocks of grass, and often on fences and under stones and logs. When food is abundant they are usually to be seen in the fields, but on the grasses, &c., drying up they will often attack fruit trees. One orchardist near New Norfolk said that during one season he lost two hundred out of a thousand apple trees through the ravages of these insects; they eat first the leaves, then the young shoots, and finally the bark. In March, 1902, a considerable number of apple trees at Glenora had nearly every leaf eaten off by these grasshoppers; many of the apples themselves were partly eaten, and the owner stated that he usually pulled these off and threw them down for the grasshoppers to feed on, and so to save the remaining apples. Some nursery stocks at the same orchard were considerably injured. Elsewhere many young trees have been injured.

Mr. F. H. Stephenson, of King Island, writes of these insects:- "These are swarming in most parts of the island, and spoil a great deal of feed, and completely demolish any small patches, such as gardens; but they come at a time of the year when we expect most of the feed to be dry, and con-



Destructive Wingless Grasshopper (enlarged).

sequently do not cause such serious damage as they otherwise would do. When the young grass shoots, generally in March, the grasshoppers are beginning to disappear. Still, they are a serious nuisance, and will become more so as people go in for lucerne or other grasses for summer feed."

Spraying fruit trees with Paris green or other arsenical poison will destroy all grasshoppers which eat the leaves or bark, and such a spray would be useful in destroying all sorts of leaf and bark eating beetles and grubs. The bran, arsenic, and sugar mash described in the section dealing with remedies is also useful against these insects.

The Earwig.

Probably the most disliked insect of all the commoner garden pests is the earwig, the species so common about Hobart (*Forficula auricularia*) being an introduction from England. This insect is practically omnivorous, devouring parts of plants, the paste in the binding of books, bread, jam, and even other insects, including the earlier stages of the codlin moth. They eat small holes in apples, pears, peaches, plums, and apricots; usually feeding at dusk and at night-time. Short-stemmed apples and ripening apricots are especially subject to attack.

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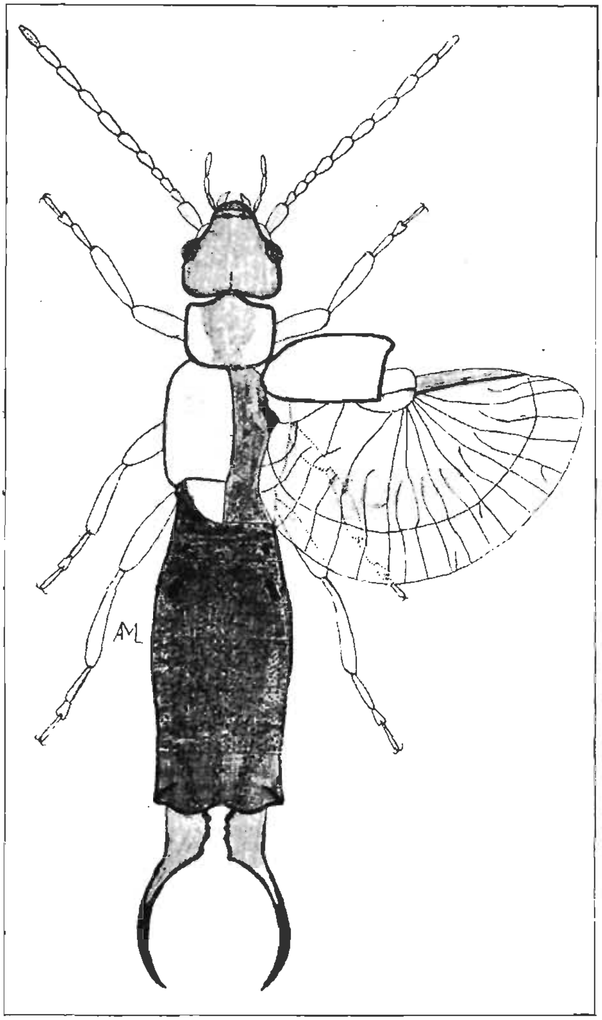
To the growers of choice garden flowers, especially dahlias, carnations, and chrysanthemums, earwigs are an unmitigated



The Common Earwig (enlarged).

nuisance, as they destroy the petals and stamens of the flowers, and many of the buds. Tender leaves and shoots are fre-

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quently attacked, and many seedlings are eaten off as soon as they appear above ground. They are sometimes very destructive to young potato plants and young French beans.

One of the oldest and best methods of trapping earwigs in gardens is to place pots or tins partly filled with straw or brown paper on tops of sticks in amongst the flowers; the shelter thus offered attracts many earwigs, so that on examining the paper in daylight the earwigs can be shaken to the ground and trodden on, or if in large numbers, shaken over a bucket of water on which is a thin film of kerosene. Brown paper crumpled up and thrust into the forks of trees, or in gooseberry or other bushes, will sometimes attract immense numbers; as will old sacking and small heaps of straw. Earwigs can also be poisoned by mixing some wet bread and fat with arsenic or Paris green, care, of course, being taken to place it away from poultry. The bran, arsenic, and sugar mash has also been found useful against earwigs.

If an inverted umbrella is held under the flowers, and these shaken into it, large numbers can be obtained, especially at night-time.

It may be mentioned that fowls, and most cage-birds, are very fond of earwigs.

The nippers at the tail end of the earwig are not poisonous, although it can inflict a sharp nip with them; one of their principal uses is to fold the wings after flight. For nearly all adult earwigs can fly, their wings being closely packed beneath the wing covers. They seldom fly, however, except about dusk. The young are without wings, and their nippers are soft and feeble. The eggs are elliptic, creamy-white, and from one to two dozen are laid in clusters, the mother watching over them and the young when hatched like a hen over chickens.

DIPTERA OR TRUE FLIES.

Fruit Flies.

In Australia there are two very serious pests of fruit that have not yet established themselves in Tasmania; these are the Queensland fruit fly (*Tephritis tryoni*) and the Mediterranean fruit fly (*Halterophora capitata*). They both attack ripening fruits, and in some parts practically destroy the entire fruit crops. The Queensland fly we shall probably never be troubled with, but maggots of the Mediterranean fly are seen in numbers every year in fruit from Sydney, and especially in peaches and oranges. It was present for a short time in Launceston, where it attacked peaches, apples, and pears; it was, however, promptly stamped out by the liberal application of kerosene to the ground beneath the affected trees. As it is a pest, however, that may at any time establish itself, it would be well for growers to keep a sharp look-out for it. In the early stages of its attacks the fruit is scarcely marked, but as it develops small watery-looking patches can be seen, and in these patches small holes appear. On cutting into the fruit, this is to be seen swarming with maggots, from 10 to 60 being about the range in numbers, although over 100 have been seen in a single peach. The harder apples are seldom attacked, but the softer ones often are. If it ever becomes firmly established in Tasmania, however, probably the most damage will be done to pears and peaches, then in a less degree to apricots

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and the softer apples. From Sydney, it has been seen in peaches, nectarines, apricots, quinces, persimmons, oranges, mandarins, and lemons; but it occurs in many other fruits as well. The Queensland fly, so far, has only been seen here in bananas and mangoes.

Ferment Flies.

Decaying fruits and vegetables are usually attacked by the ferment or vinegar flies (*Drosophilus*), and in Tasmania they sometimes cause alarm through being mistaken for fruit flies. As a matter of fact, any of the softer fruits or small fruits, as soon as they commence to go bad, are attacked by these insects, the maggots of which simply swarm over them: these maggots in general appearance somewhat resemble fruit fly maggots, but are smaller and thinner. The flies themselves are much smaller than fruit flies, and are yellowish in colour, with beautiful red eyes.

On one occasion a parcel of Tasmanian dried apples was condemned in Sydney on account of these flies. The apples had been allowed to get wet: they naturally started to ferment, and the flies at once attacked them, so that when opened up in Sydney thousands of maggots were seen swarming over the fruit. In drying and jam factories, when everything is not kept scrupulously clean, these flies can be seen in large numbers.

Blue Tomato Fly.

The tomato is often attacked by the maggots of a fly known as *Lonchæa splendida*, and these maggots have frequently been mistaken for those of fruit flies, but the insect is not known to attack fruits. To the tomato, however, it is often very troublesome. The fly itself is smaller than the common house fly, and is of a beautiful deep-blue colour.

Leaf-attacking Flies.

The maggots of a number of kinds of flies live between the two skins of leaves, and are often so numerous as to seriously damage the plants attacked. Two species are very common in Tasmania, and both belong to the genus *Phytomyza*.

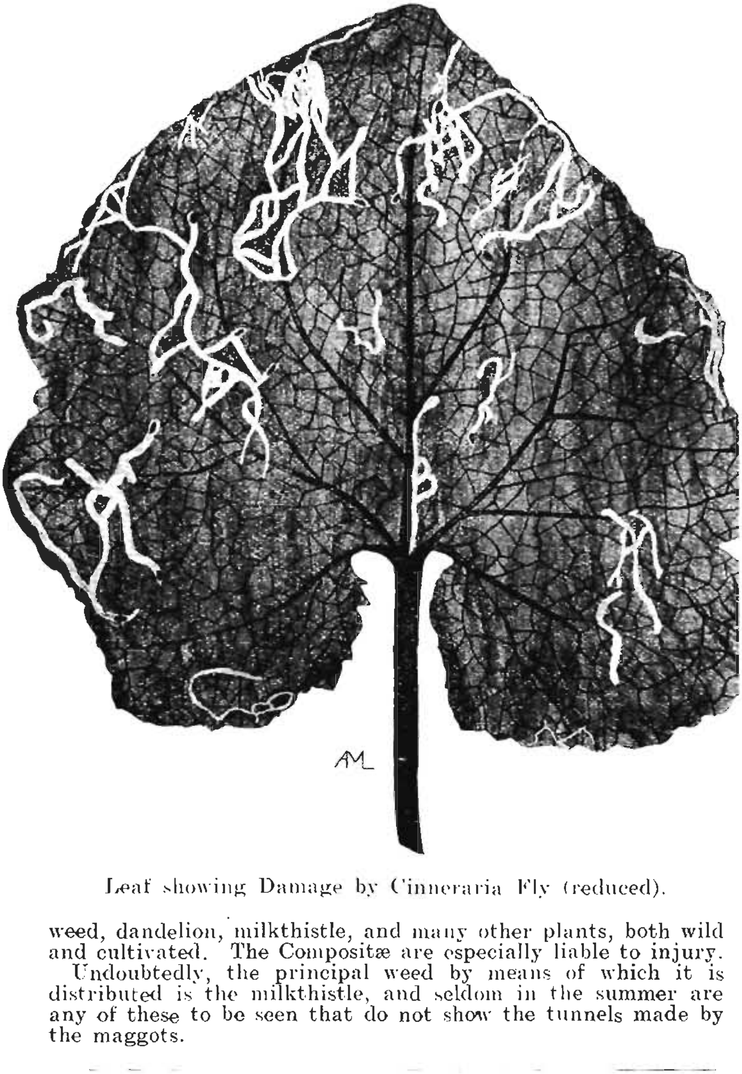
The Marguerite or Cinneraria Fly.

This fly (*Phytomyza nigricornis*) is supposed to be a native of Europe, but is rapidly becoming world-wide in its distribution. In Australasia, it first appeared in New Zealand, but it soon spread to the eastern States of Australia. In 1895 it was unknown in Western Australia, but two years later it was very widely distributed in that State. In Tasmania there is probably not a single garden in which it is not present.

The eggs are laid on the leaves, usually on the under surface. The maggot, on hatching out, drills its way between the two skins of the leaves in a more or less corkscrew fashion; it becomes full-fed in less than a fortnight, and then changes to the pupal form, and a few days later to a fly. The whole process, from egg to fly, is so rapid that there are many broods in a season. The tunnels made by the maggots show up white in the leaves, and are often so numerous that more than half of a leaf is affected, and a perfect network of tracks appears. In very bad cases practically the whole of the inner portions of the leaves are destroyed, and the leaves wither up. The tunnels are quite plain to the naked eye, but on holding the leaves up to the light the maggots and pupæ can be seen;

the former having the usual appearance of very small maggots, and the latter looking much like small elongated seeds. The flies themselves are very small, their bodies being hardly larger than the head of a pin.

This fly is known to attack the marguerite, cinneraria, cosmia, sunflower, geranium, dahlia, chrysanthemum, marigold, nasturtium, lettuce, celery, carrot, parsnip, pea, tobacco, cape-



Leaf showing Damage by Cinneraria Fly (reduced).

weed, dandelion, milkthistle, and many other plants, both wild and cultivated. The Compositæ are especially liable to injury.

Undoubtedly, the principal weed by means of which it is distributed is the milkthistle, and seldom in the summer are any of these to be seen that do not show the tunnels made by the maggots.

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Practically nothing can be done against this pest, except gathering and destroying the affected leaves and keeping down weeds which harbour it. Simply throwing the leaves on to the rubbish heap is not sufficient, as the maggots are not destroyed, and soon turn into flies.

The Beet Leaf Fly.

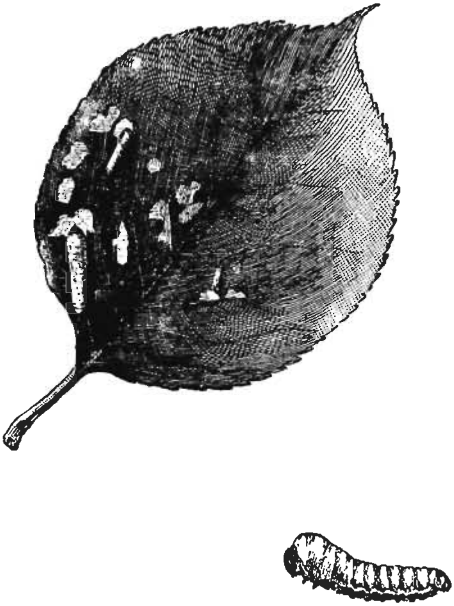
This is a fly closely allied to the preceding, but much smaller, and known as *Phytomyza betæ.* It appears to be an Australian species, and in Western Australia attacks a number of fleshy-leaved plants, including some poisonous ones. In Tasmania it does considerable damage to the leaves of the beet and mangel. The leaves attacked appear to have numerous whitish tunnels driven through their substance; the tunnels, as a rule, being much more numerous than the tunnels of the cinneraria fly, but, of course, very much smaller. When very numerous, both beet and mangel are seriously injured.

As with the cinneraria fly, no effective spray at a reasonable cost can be used against this pest, and the only thing that can be done is to gather and destroy the affected leaves.

HYMENOPTERA, OR ANTS, BEES, SAWFLIES, &c.

Pear or Cherry Slug.

The most serious insect pest of the pear in Tasmania is undoubtedly the pear or cherry slug (*Selandria cerasi*). This



The Pear Slug and an Attacked Leaf.

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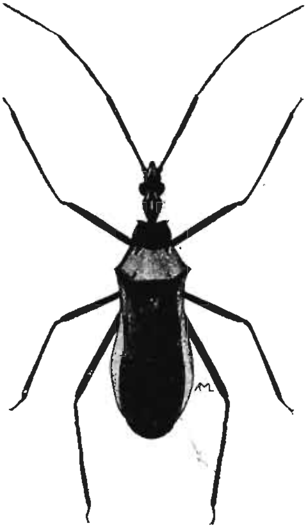
pest attacks other fruits, notably the cherry and plum; the medlar, quince, and hawthorn are also much attacked by it, and it is occasionally seen on the apple and almond.

Pear trees that are attacked by it frequently lose their entire crop of leaves, the fruits themselves hanging unprotected on the trees in a most forlorn manner, so that they become sunbaked and worthless. Cherry trees frequently lose their entire crop of leaves, but usually not before the fruit has been picked—many cherry trees are killed outright by it. The plum is rather severely attacked.

The hawthorn also is severely attacked, and is probably responsible in a great measure for its extended distribution, as hedges of it extend sometimes for miles (near Launceston there are 32 miles of hawthorn hedges belonging to one estate, every yard of which is attacked by this pest). Many trees and hedges are neglected, not the slightest endeavour, in many



Pirate Bug *(Cermatulus)*, enlarged.

cases, being made to keep the slug in check, even when the hedge is used as a breakwind for orchards.

This pest—perhaps more so than any other in Tasmania—is easily kept in check; the larvæ (blackish slimy objects, somewhat like small tadpoles in appearance) live exposed whilst feeding, and are very sluggish in their movements, so that any contact spray, or arsenical poison, can be used against them. Where the orchard or garden is small, probably the most convenient material to use is hellebore. This substance is also very useful for trees on which fruit is ripening, such as the cherry and plum. It is comparatively cheap, but much dearer (in proportion to the quantity used per gallon) than Paris green or arsenic and soda. For hedges and large orchards the best and cheapest material to use is the arsenic and soda mixture; this can be used at the rate of 1 lb. of arsenic to 400 gallons of water. For pear orchards Paris green

(at the rate of 1 lb. to 200 gallons of water) is very useful, and will also help to keep the codlin moth in check. January is usually the best month in which to spray, and (providing the spraying is not done immediately the slugs appear) one spraying is usually quite sufficient; any spraying done later than January for the pear, however, should not be with arsenical poisons, as these are liable to cause the fruit to appear spotted when sold.

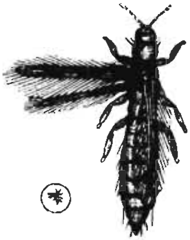
Pear slugs in Tasmania are frequently eaten by a species of pirate bug of the genus *Cermatulus*; a species which has occasionally been seen eating codlin grubs and other destructive insects.

When spraying with Bordeaux mixture for black spot, if Paris green is added (at the rate of 1 lb. to 250 gallons), any slugs which may be present will be destroyed. Kerosene emulsion, when sprayed on scaly trees, will destroy the slugs, as well as a large proportion of the scales; but when only the slugs are present, is needlessly expensive.

THYSANOPTERA OR THRIPS.

Thrips.

These are very minute insects, which, when full grown, are usually black; they have then two pairs of beautifully fringed wings; when young they are usually yellowish, but are sometimes of a bright blood red. One species attacks the onion, and in some of the warmer parts of the world is very destructive. On the wattle blossoms they are often to be seen in millions. In Tasmania they are often exceedingly numerous in apple and pear blossoms, although they appear to do no serious harm to them; later on they may be seen in the eyes of the fruit; they are also known to eat the spores of black spot. The best known kind, however, is one which is quite a serious pest to flowers, &c., grown in glass-houses and bush-houses; there they are often so numerous as to badly injure many of the plants. The insects usually occur in patches, young and old being mixed up together; the leaves look fly-speckled and yellowish, and when small (as with fuchsias and geraniums) will often fall off. The most approved gardener's remedy is washing the insects off with soapy water to which a little tobacco or nicotine has been added. Another kind of thrips forms a peculiar gall on the leaves of the black wood or light wood in Tasmania; another forms a highly remarkable bladder-like gall on the mulga in Western Australia.



The Thrips (enlarged).

These insects frequently fly into the eyes at dusk, and cause intense irritation to those organs.

Onion Thrips.

In Tasmania the onion is often attacked by a minute insect known as *Thrips tabaci*, a very small yellow species. The larvæ are slightly curled and wingless—on fully matured specimens wings are present, but they are small and greyish, and can scarcely be seen without a magnifying-glass. The affected

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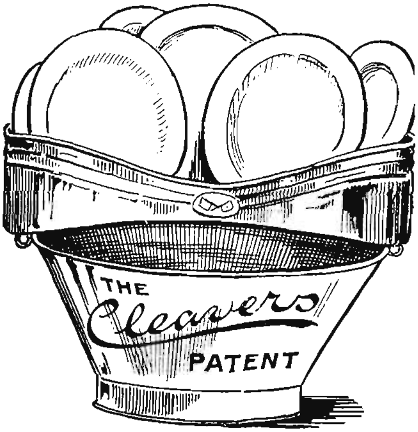

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leaves appear greyish to the eye, and the tops will frequently wither; on examination they appear as if covered with fly-specks. On one leaf thousands of these insects may often be seen, as a rule congregating towards the centre of the plant, and often crowding on each other. Besides onions, they may often be noticed on peas, beans, pumpkins, melons, and other garden plants. On cabbages they sometimes occur, covering patches from half an inch to 4 inches square, and occasionally even penetrating to the heart. In Tasmania this pest is occasionally severe, although to a less degree than it often is on the mainland.

All the species of thrips may be readily destroyed by spraying with weak kerosene emulsion, or hellebore, or in fact with any of the contact sprays.

MITES OR ACARIDÆ.

There are several kinds of mites in Tasmania which attack fruit trees, both above and below ground; others which attack vegetables; and others flowers, grasses, &c.

The Red Spider.

The red spider (*Tetranychus telarius*) is a minute creature of a reddish or reddish-grey colour; it usually feeds on the under-surface of leaves, and covers these with a fine web. It is sometimes a rather serious pest of the hop, and few garden plants are completely free from its attacks. In warm countries the best remedy against it appears to be sulphur, but in Tasmania probably the best will be found to be kerosene emulsion. In applying this (or any other mixture) care must be taken that the spray is directed on to the lower surface of the leaves, and the spraying should be thoroughly done, as if any are left alive these soon breed.

The Red Mite.

The red mite (*Bryobia pratensis*) in appearance is much the same as the red spider, and is frequently called the red spider. It differs from that species, however, in several features, and in particular by the fact that it does not spin a web.

It attacks many kinds of fruit trees, and is sometimes very destructive, especially in spells of long dry weather, when it can breed without interruption. A good heavy shower of rain will destroy it in countless thousands. On the apple it first appears on the opening leaves, many of which are thickly covered, and so prevented from becoming fully developed, and it continues feeding well into autumn, when the leaves begin to fall. The leaves that are attacked have a peculiarly speckled appearance, owing to the rupture of their cells, and a badly-attacked tree can be noticed some distance away; the leaves also will generally fall sooner than they would do if not attacked. In Tasmania the apple tree is the principal sufferer by this pest, but the pear is also occasionally severely checked by it, and the plum and peach to a less extent.

The mites, on the approach of winter, lay their eggs in the forks of trees and in any little crevices they can discover. They are frequently to be seen in great numbers in codlin moth bandages. The eggs are of a bright red colour, and are some-

times so numerous that they cause the forks of the trees to appear as if coated with red paint.

Against the eggs, in winter (the best time for treatment), any of the remedies recommended for the mussel scale will be found to be quite effective; but they should be well applied to the trunk, and especially to where the twigs and branches fork out. In the summer kerosene emulsion will be found useful against them, but one spray will not be sufficient, as some of the mites and their eggs are certain to escape a first spray.

A minute black ladybird beetle, known as *Scymnus vagans*, feeds on both the red spider and red mite, and in some cases keeps them well under. The beetles themselves are so small that two or three of them could find standing room on the head of a pin.

Gooseberry Mite.

A pest which is sometimes destructive to the gooseberry is the gooseberry mite, but at present it is not widely distributed in Tasmania. In one orchard at Sandy Bay, however, it has been rather serious, as in one year fully half of the crop was destroyed by it. The young shoots when attacked look sickly, with the leaves stunted, yellowish, and rough, with brownish withered patches; a great proportion of the fruit also falls before maturity. Spraying the bushes in the winter with a strong oil emulsion would probably be of great assistance against this pest; but in summer little or nothing can be done against it.

A Mite of Vegetables.

At Bellerive (and probably elsewhere in Tasmania) a blood-red mite attacks the seedlings of many garden plants and vegetables, but usually only the very young leaves. Cabbages and peas are especially subject to attack, and are frequently killed by it.

A little sulphur sprinkled in seed-beds would probably prevent these mites from doing much damage.

A Destructive Root Mite.

The roots of many plants in Tasmania are attacked by a watery-looking mite, in general appearance something like the cheese mite. It is known as the bulb mite, *Rhizoglyphus echinopus* (meaning spiny-legged root-eater). It is very small, and a good magnifying glass is needed to see it at all clearly, but the figure* on the next page will give a good idea of its general appearance.

This pest occurs in many parts of the world, and attacks a multitude of plants. Stored onions and bulbs are frequently attacked and seriously injured; when attacked they appear to be covered with a kind of greasy dust, this being due to the bodies of the mites and their droppings. The Christmas lily appears to be specially subject to its attacks. When the mite appears, as with most other mites, it is generally in enormous numbers.

Some seedlings are attacked as soon as they commence to grow, with the consequence that they just break through the

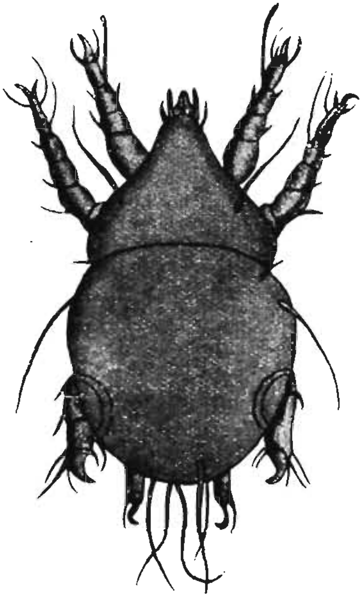
* From *Journal of the Board of Agriculture*, London.

ground and die, or they may not even break ground before dying. The mite, in fact, is sometimes the real cause of the apparent failure of seeds germinating.

Carrots are sometimes attacked just where the leaves join the carrot itself. In consequence, the leaves fall off and the top commences to rot and hollow out, in time the whole carrot becoming rotten.

Cuttings, when put in the ground, will often not root on account of this pest, and on examining such cuttings it will be found that the bark has rotted and is swarming with mites.

Whilst healthy plants are often attacked, the mites seem to prefer to attack plants which have been injured in some way,



Root Mite (enlarged).

or which are growing under unhealthy conditions. Verandah plants, for instance, are frequently attacked, as are also plants growing in glass houses or green-houses.

With fruit trees it usually appears only after the roots have been injured by having the bark bruised in cultivation or weakened by the attacks of fungi or insects. Once it appears, however, the plant attacked, whether an apple tree, a carrot, or a flower-cutting, &c., is nearly always doomed.

When the roots of the apple are attacked the bark of the root softens and readily tears off, and on examination is seen to be swarming with the mites in places, and small roots do not grow on the attacked parts. The wood of the roots is not

directly attacked, but there is usually a certain amount of slimy liquid (caused by the mites) between the wood and the bark. The trunk, a few inches above ground, is also sometimes attacked, the mites seeming to work upwards from the rotting roots.

Sulphur will prevent the mites attacking stored bulbs, and will also protect cuttings from their attacks; but once they have obtained access to the roots nothing practicable (if expense is considered) can be done against them.

The Pear Mite.

In some parts of Tasmania, and especially in the north, the pear mite (*Phytoptus pyri*) is becoming rather troublesome to the pear.

It appears first in spring, in the young leaves, starting as reddish blisters; as the leaves expand the blisters get darker and darker, till in the fully-matured leaves they appear as rough brown spots, in this condition being frequently mistaken for black spot.

So far as is known the pear is the only fruit tree attacked by this pest in Tasmania, and some trees are very badly disfigured by it. It is important to know the difference between leaves affected by this pest and by black spot, as many people have sprayed their trees with Bordeaux mixture and other fungicides against it without doing the slightest amount of good.

It can be readily distinguished from black spot by the reddish blisters on the young leaves. On matured foliage with black spot the leaves are thinner than elsewhere at the spots where the disease appears; but with pear mite at the brown spots the leaves are thicker than elsewhere, and the skin can be easily lifted with the point of a penknife, exposing beneath spongy-looking tissue in which, with a strong magnifying glass, the mites can be seen.

Nor should it be confused with the red mite (*Bryobia pratensis*) which often attacks the pear in early summer, and sometimes seriously checks its growth. The red mite attacks the outer parts of the leaves, and its eggs on the approach of winter are often laid so thickly that the forks of the trees appear as if covered with red paint, the eggs of the pear mite on the contrary being quite invisible to the naked eye.

The blisters are usually single, but when very numerous they are often united. In bad cases sometimes every leaf on a tree is attacked, and many of the leaves have more than half of their area affected.

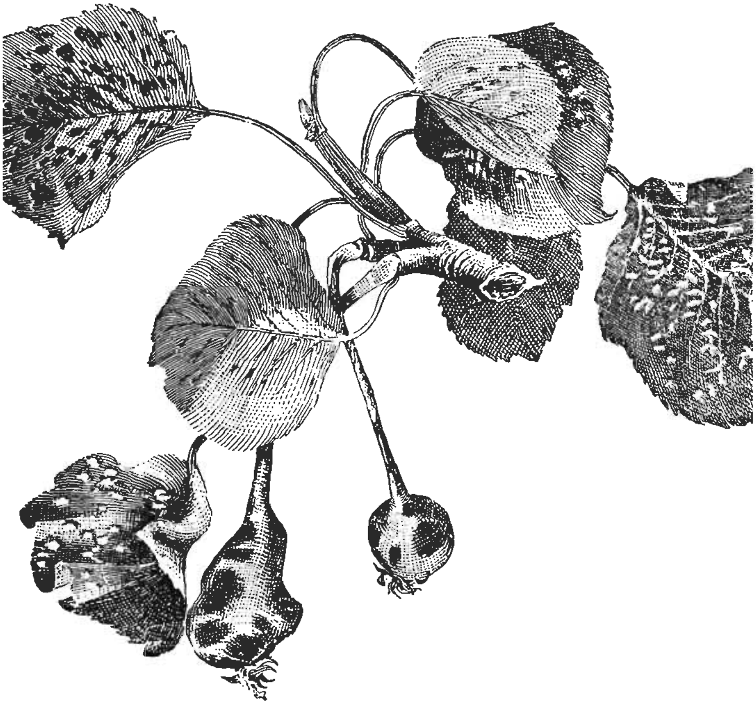
The mites, which are quite invisible to the naked eye, are long, and narrow, whitish in colour, slightly curved, and with only four legs instead of eight, as most mites have. On the approach of winter they forsake the leaves and lay their eggs in the buds and rough bark.

From the time the reddish blisters appear in the young leaves till the old leaves fall, no spraying is of use; as the mites, living within the leaves themselves, any spray which would kill them would also destroy the leaves. On examining

the leaves at the end of the summer small holes can sometimes be seen in the blisters, these being made by the mites when quitting the leaves to deposit their eggs.

Spraying should be done in the winter to destroy the eggs which are sheltering in the buds and bark; sprays such as crude petroleum, kerosene, or red-oil emulsions, or the sulphur, lime, and salt, being very useful; but in putting any spray on care should be taken to cover all the small twigs as well as the trunk and main limbs. Every part of the tree above ground should, in fact, be thoroughly wetted.

In a young orchard when the pest first appears it is advisable to cut off and destroy, before the end of summer, all



Pear Mite on Leaves, and Black Spot of Pear on Fruit.

shoots showing any trace of it. If left till the ordinary pruning is done the mites and their eggs will be sheltering in the bark and buds.

Before setting out young trees it is advisable to dip the parts above the roots in kerosene emulsion, or in a strong decoction of hellebore. These would not injure the trees themselves, but would destroy all the eggs and mites and any scale insects, &c., which were present on the young trees. It is almost solely by means of nursery stocks that this pest is distributed.

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MISCELLANEOUS PESTS.

Snails and Slugs.

A great amount of damage (often unsuspected) is done in flower and vegetable gardens by snails and slugs. On rainy nights, especially in warm weather, they may be seen coming out from hedges, fences, rockeries, outhouses, and sides of buildings in countless numbers; they also frequently seek shelter under large leaves, such as those of the cabbage and different kinds of lilies, the iris being a special favourite.

Both snails and slugs produce an abundance of slime, which serves a double purpose: it enables them to move about more rapidly, and it is a protection to the skin beneath it.

These pests can be destroyed in many ways. Quicklime and soot, either together or separately, can be dusted on them at night time, and will destroy all that are touched: salt also is useful. When they are found to be destroying vegetables in the market garden, as good a plan as any is to throw coarse salt broadcast over them at night time, or very early in the morning before they have retreated to cover. Whether salt or lime is used, the application should always be at night time, and in showery or misty weather. It will also be found advisable not to start too early, as many of these pests do not come out into the open till after 9 o'clock at night. Poisoned cabbage leaves are sometimes used. Ground tobacco is perhaps the best of all to use for dusting in the flower garden. The bran-arsenic-treacle mash will be found most useful as a protection in gardens, and should be placed where it will be protected from the sun, and be near the slugs and snails when they commence to move; putting it in lumps about the size of walnuts where required. This mash will destroy a great many snails, slugs, earwigs, cutworms, mice, and rats; but should be placed where poultry cannot get to it.

When they are very abundant in gardens, it is often desirable to gather them by hand, as even if the animals in them are killed, snail-shells remain scattered about and look very unsightly. A damp or rainy night should be selected, and both snails and slugs can be quickly destroyed if thrown into a bucket of water on which is floating a thin film of kerosene.

Slugs and snails are eagerly eaten by domestic poultry (especially ducks) and by starlings; frogs also eat them when small.

The Common Snail.

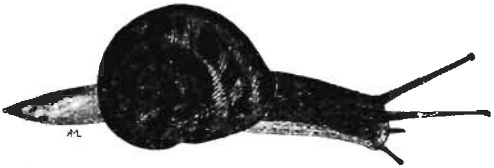
The snail so common in many Hobart gardens is an introduced species (*Helix aspersa*), and is very destructive in wet weather to growing plants and seedlings, but especially to peas and beans.

Although the body is apparently entirely soft, there is within the mouth a ribbon-like contrivance (known as the radula) which is thickly set with minute, but sharp and hard teeth: these are brought in contact with the leaves attacked, and so the surface of these is quickly rasped away.

The outer shell, although apparently firmly fastened to the living animal, is in reality only held in position by certain curved portions of the animal itself; this can at will be entirely drawn into the shell. The shell is of lime, and varies

in thickness according to the amount of lime in the soil; it is of a yellowish colour, more or less irregularly mottled by stripes of brown. The shell, when of full size, is about an inch in length. The animal when moving is between 2 and 3 inches in length.

Before the winter, snails usually congregate together in numbers in sheltered places, and remain there in a dormant state till the following spring; in very dry weather they will also remain dormant. At such times they secrete a thick film of slime at the mouth of their shells, and this hardens and



The English Snail (*Helix aspersa*), reduced.

protects the animals inside from drying up, and also from the attacks of numerous enemies.*

The eggs are stated to be laid in batches of 60 to 70, and to hatch in about 15 days in suitable weather.

Slugs.

Although without shells on their backs, slugs belong to the same class (the *Mollusca*) as the snails, and they obtain their food and shelter in much the same ways.

On examining a seed-bed at night-time thousands of young slugs may sometimes be seen, that, on a cursory examination, would escape notice altogether. These small slugs, in fact, are often responsible for the apparent failure of seeds to grow, for the young plants are eaten off as soon as they appear above ground.

In favourable localities slugs will climb apple trees and eat large holes out of the fruit; but attacks of this nature can easily be checked by putting rings of lime or soot round the trees, or better still, by the bran, arsenic, and treacle mash, which will kill them. In one year Mr. E. Aylett, of Wynyard, was much troubled with slugs, and estimated that he lost between 200 and 300 bushels of apples through them. He wrote, "The slugs first attacked the blossom by biting through the centre, causing the other parts to drop off. When the apples are the size of marbles, they bite them off in great quantities. They are destructive to peaches also."

There are several kinds of slugs in Tasmania, some being natives, whilst others have been introduced. The large one common in Hobart gardens is an introduced species (*Limax maximus*): it is of a slaty-brown colour, with three feeble paler stripes; the lower portion is of a very pale yellow. When full grown and extended in moving it often measures over 4 inches in length. A curious feature in connection with

* If hibernating snails are taken and placed in boxes in thoroughly dry situations they may be kept for years in a dormant state, and yet brought back to full vigour by placing them in water.

this one is the fact that small whitish mites may often be seen running over its body, sometimes hundreds being on a single slug.

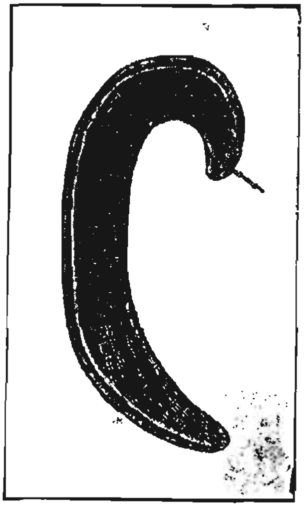
The Large Garden Slug (*Limax maximus*), reduced.

The eggs of the common slug are beautiful semi-transparent objects, and may often be seen under logs and stones in wet or shaded situations. In size, they are rather larger than the seeds of the sweet pea.

In open fields, and especially near swamps and creeks, some field slugs are very destructive to grass.

Millipedes.

There are many kinds of millipedes, or false wireworms, in Tasmania, and some of them are rather destructive to the roots of nursery stocks; they sometimes also eat large holes out of potatoes and strawberries, and many choice garden plants are also injured. They are worse in damp, loose soil than in clayey ground.



A Common Garden Millipede (enlarged).

The one shown herewith, and which is very commonly called a wireworm, appears to be the commonest. It is of a slaty blue colour, with an obscure dark stripe on each side, on each side of which is an obscure pale stripe. It sometimes measures about an inch in length, but is usually much smaller. It has considerably over 100 legs; but these do not come out very well in the illustration. Millipedes are mostly to be found below the surface of the ground. They gnaw the outer parts of the roots, and sometimes eat fairly large holes out of the stems. They usually move about at night. Millipedes, the adult click beetles, and some of their wireworm larvæ can be trapped in fairly large numbers in the summer by laying out slices of mangolds, old cabbage stumps, &c., and examining the undersurface of these in the mornings.

Wood-Lice or Sow-Bugs.

These are sometimes very destructive to young plants just as they show above ground, and especially to beans, pumpkins, marrows, tomatoes, and young fruit grafts; in shaded

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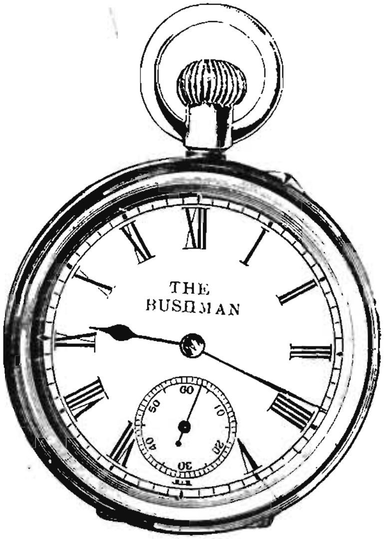

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places they will also attack the leaves of gooseberries, currants, and raspberries. They can be trapped in large numbers by placing empty boxes (or bones on top of old sacks) at the side of the garden, and into these the wood-lice will creep on the approach of day. The boxes also will attract many earwigs and snails.

ANIMAL PARASITES AND DOMESTIC INSECTS.

It is well known that many animals are attacked by insects or allied creatures, such as ticks and mites. Some of these are of most extraordinary forms, being very different in appearance from other members of the families they belong to. Man himself does not escape, as three distinct species of lice, two fleas, and several mites regularly attack him, whilst he is subject to the attacks of many others. There are also many internal parasites (tape-worms, thread-worms, flukes, &c.), but here it is not intended to deal with any of these.

Of late years considerable attention has been paid to insects in their relation to diseases, especially those of the tropics. Mosquitoes of several kinds are now well known to be responsible largely, if not almost entirely, for the dissemination of malarial fever. Fleas are largely responsible for bubonic plague. Flies carry the germs of typhoid, anthrax, smallpox, and other dangerous and loathsome diseases. Ticks are supposed to be the sole carrying agents of the Texas cattle fever, so destructive of late years in Queensland. The tsetse fly (*Glossina morsitans*) renders a large part of Africa uninhabitable for horses and some other animals; whilst a similar fly (*Glossina palpalis*) is responsible for the sleeping sickness of Uganda, a disease which of late years has caused the deaths of thousands of negroes and a few whites, and from which, until quite recently, there have been no recoveries. Yellow fever is now being successfully controlled in some parts of America and adjacent islands, formerly very subject to it, by the treatment of exposed water for the destruction of the insect life in it, such insects being, when matured, responsible for the dissemination of the fever.

The statement is often heard, even from well-educated and otherwise intelligent people, that spontaneous generation of parasitic insects occurs that it is quite natural for children to have lice in their heads, dogs to have fleas, sheep to have ticks, and so on. Spontaneous generation of even the lowest forms of insect life has never yet been proved, and never will be. Over and over again claims have been put forward that certain low forms of life have been generated spontaneously, but these claims have always been disproved. That great variation has taken place, and is continually taking place, very few will now deny, but the old dictum that it takes life to generate life still holds its own.

Parasitic insects are very readily communicated from one animal to another, and especially to the young from the mother. Most young animals, in obtaining milk from their mother, butt up against the udder. This must often be the cause of such parasites as are in the vicinity starting to move, and in many cases passing from the mother to the head of the young. The young animal also frequently sleeps or rests

at the side of its mother, and having a thinner skin than its mother is naturally more attractive to lice. When pairing takes place, also, parasites must sometimes remove from one animal to another.

But it is not always necessary for two animals to be close to one another for parasites to be distributed; infested animals frequently rub themselves up against posts, &c., and must often dislodge the parasites or their eggs, and the parasites would eagerly seize the chance of attacking the next animal that came that way. Any animal also that rested on the spot where another animal had rested or slept would become liable to infestation. There is no doubt, also, but that parasites or their eggs could be communicated from one animal to another by means of harness, &c.

With some of the true ticks (the Queensland cattle tick, for instance) enormous numbers of young are produced, and these wait on grass stems, &c., until a beast passes by, when it is at once seized upon, some of the young being capable of living for months without food.

With birds, of course, parasites have numerous chances of passing from the adults to the young.

There are a few cosmopolitan insects which at one time or another are almost certain to make themselves noticed in or about the house, no matter how cleanly kept, and others which are almost always present.

The Bot-fly of the Horse.

This fly (*Gastrophilus equi*) is very troublesome in Tasmania, and, in common with all other bot-flies in Australia, has been introduced, probably from Europe. Horses when they hear it about them get very restive, and sometimes act as if mad. Most kinds of bot-flies, in fact, seem to have a maddening effect upon the animals they attack.

The fly, when attacking a horse, will often pass along the belly till it comes to the chin, on the hairs of which it lays its eggs, or these may be laid on the shoulders or hairs of the fetlocks. Each egg is provided with a lid or operculum, and about a week or a fortnight after being laid this gets loose, and on the horse licking the place it breaks free and the young maggot escapes, and is often licked direct into the mouth, the empty egg-shell remaining attached to a hair, where it will sometimes remain for a couple of months. The eggs seem to cause a certain amount of irritation to the horse, with the result that it bites or rubs the parts effected, and it sometimes gets the eggs into its mouth in this way, or by way of its food. No doubt many eggs perish, but as each female fly lays a multitude of eggs provision is made for this. Once in the stomach the heat soon hatches the eggs; and the young maggot fastens itself to the walls, where it remains till full fed, a period of from seven to nine months. On becoming full-fed it releases its hold, and passes from the animal's body with the dung: it then bores its way into the ground, and turns into the pupal stage, to appear in a month's time, or a little later, as a fly.

If only a few maggots were in the stomach, probably not much harm would be done, but they sometimes occur so thickly that in places the walls of the stomach are completely covered

with them, and the horse, in consequence, becomes thin and poor, and sometimes dies.

Professor Osborne, of the United States Department of Agriculture, in speaking of the pest, says:-

"The injury to the horse from the larvæ may take four forms—(1) The attachment to the walls of the stomach causes an irritation which may interfere with the normal action of the glands or reduce the extent of glandular surface; (2) the bots abstract some nutriment from the walls of the stomach, or, by absorption, from the contents of the stomach itself; (3) by collecting, particularly in the region of the pylorus, they serve as an obstruction to the free passage of food from the stomach to intestines; (4) in passage through intestines they may attach themselves at times to walls or in rectum, and cause great irritation."

The maggot is stout, about half an inch in length, and each segment is set round with numerous hooks. The fly itself is about half an inch in length, and covered with short fine hair, which is denser and browner on the thorax than elsewhere. Its abdomen is pointed and curved underneath the body, and the head is comparatively small. The flies are most numerous in Tasmania during January and February.

In order to check this insect care should be taken to prevent the eggs from being laid, or to kill them before the young maggot hatches. The hair of the chin and fetlocks should be singed or clipped off, or rubbed over with an oily rag. The oil will not only destroy all the eggs it touches, but the smell of it will prevent the fly from laying her eggs. The vitality possessed by the maggots is remarkable; they have been placed for hours in strong spirits without being killed, and innumerable drugs have been tried against them with little or no effect. Turpentine, perhaps, is the favourite remedy.

The False Bot-fly or False Bee.

There is a fly (*Eristalis tenax*) that in Australia and Tasmania is frequently mistaken for the bot-fly, and sometimes for a bee. In appearance it is something like a bot-fly, but is larger, much less hairy, and its abdomen is not curved beneath its body; the venation of its wings is also different. It may be commonly seen on flowers, when it moves its abdomen up and down, much the same as a bee does, and it is difficult at times to believe that it really is not a bee. When in the vicinity of stables it is often mistaken for a bot-fly, but it only visits such places to deposit its eggs. These are laid in any place where there is stagnant water, such as cesspools, drains, &c. The maggots are very peculiar, having a long tail-like appendage, which causes them to be commonly known as rat-tailed maggots; they live in all sorts of wet, rotting substances. This fly, in fact, so far as man is concerned, is neither useful nor destructive, and is only mentioned here as it is so frequently mistaken for the bot-fly.

The Ox Warble.

This is the maggot of a large bot-fly (*Hypoderma lineata*) which does a considerable amount of damage in Europe and elsewhere. In its last stages it lives beneath the skin of cattle,

and causes an appearance as of large boils · when at all bad, not only is great pain caused to the animals attacked, but the hides are greatly reduced in value. So far it appears not to have established itself in Australasia, but the maggots have been noticed occasionally in imported stock, and at least once in quarantine in Tasmania.

Nasal Bot of Sheep.

There is no official record of this species (*Oestrus ovis*) being at large in Tasmania, but in 1905 a sheep from Sydney, slaughtered in Hobart, was found to contain five maggots in its head. The nasal bot of sheep is so called because it deposits its maggots (with most kinds of bot-fly, eggs instead of maggots are laid) about the nostrils of sheep. After the maggots or larvæ have been laid, Professor Osborne says of them, "The larvæ at once commence to work their way up the nostrils and nasal passages, causing great irritation on their way, until they reach the frontal sinuses, cavities located between the two plates of the skull, and lying on each side of the central line of the head and between and a little above the eyes. There they attach themselves by the little hooks or tentacula, placed each side of the head, to the membranes which line the cavities, feeding on the mucous which is always to be found in them" The maggots will occasionally work their way into the brain. Affected animals will frequently rush about bumping into anything in their way, and often running round and round in circles till they fall down; death often results from their attacks.

Of remedial and preventive measures, Profesor Osborne says, "To prevent it from depositing its young different means are resorted to. Some farmers turn up the soil in portions of pastures so that the sheep may thrust their noses into the soft ground on the approach of the fly, whilst others smear their noses with tar, or cause them to do so themselves. But as the fly is very persevering, and generally attains her object, the means to be most depended on is the dislodging of the larvæ or grubs, and so far lime has been thought the most effectual, and should be given them, so that by sniffing it they may be made to sneeze, and thus dislodge the grub in many cases. Some sheepbreeders are in the habit of fixing salt logs in their pastures, of sufficient length to enable all the sheep to get at them. Into these logs, at intervals of five or six inches, holes are bored with a 2-inch auger, and during the season a little salt is kept in these holes, while every few days a little tar is smeared round them with a brush. The sheep, in obtaining the salt, tar their noses, and the odour of the tar keeps the fly away. In several cases, where the grubs are already in the head, they may be dislodged in a measure by a feather dipped in turpentine, which should be run up the nose and quickly turned. This, of course, can be but partially effective, as it is difficult to reach the extremity of the tortuous canals, and it is in such localities that they must cause greatest difficulties."

The Sheep Tick.

This is an insect (*Melophagus ovinus*) which, although commonly called a tick, is really not one, being, in fact, a very

degraded fly. It belongs to a group of remarkable flies known as pupipara, owing to the habit of the females developing their young within their bodies till the pupal stage is reached. In all other flies the females either lay eggs or small living maggots, but usually eggs. The pupæ laid by these insects simply burst through their shell and appear as mature insects. A certain amount of development must take place within the pupal shell, however, as the insects do not break out till some time after being laid.

The pupæ are quite commonly called eggs by sheepbreeders, and this mistake is natural enough, although, if eggs, they would be enormously large in proportion to the eggs of other insects.

Sheep at all badly affected by these insects continually bite themselves, and rub up against fence-posts and trees to allay the constant irritation. A certain amount of wool is thus lost, and, in addition, the wool gets stained. On the whole, it has been estimated that when at all bad a loss of sixpence per sheep is a fair average due to these parasites.

The sheep-tick has been occasionally reported from goats, but so far in Australia has only been known to live on the sheep. When shearing is being done they will often wander on to the shearers, but they soon drop off.

Dipping for this pest is almost universal, many patented mixtures being used for this purpose. Dipping is usually done soon after the sheep are shorn, as a much smaller quantity of material is then required. The dipping, however, cannot be relied upon to destroy the pupæ (the so-called eggs), consequently it is a common practice to dip a second time, about a fortnight after the first application, as the pupæ will by that time have developed into ticks, and can then be destroyed.

Dipping should be thorough, and care taken that the dip actually wets the skin, especially of the head and neck, otherwise many ticks and lice will escape destruction

Fleas.

Two species of fleas very constantly attack man. These are the house flea (*Pulex irritans*) and the dog and cat flea (*P. serraticeps*). The rat and mouse flea (*P. fasciatus*) and other fleas will also occasionally attack him. Of all the fleas, that of the dog and cat is perhaps the most common in houses, and being less active than the house flea is more easily captured.

The house flea breeds in all sorts of rubbish, its larvæ being thin, legless, maggot-like, and slightly hairy. Catching and killing fleas will do but little towards ridding a house of them. The object to be aimed at should be to keep the floors as clean as possible, so that the larvæ (which can only be found by careful search) are not allowed to mature. Washing the floors with boiling water or kerosene will lessen the trouble, and if continued will eventually exterminate fleas. Covering the floors with oil-cloths or linoleums is of great assistance, but carpets and matting often serve as harbours for fleas.

Dogs should always be kept out of houses, and their kennels should periodically be turned out and scalded, and insect powder should be placed on the sacks or bagging used in them, to prevent the fleas from breeding. The dog-flea will sometimes occur in thousands on a dog that is in poor condition.

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Lice of Human Beings.

Children and people of dirty habits are especially subject to infestation by these, perhaps the most objectionable of all insects. Three kinds are commonly known to attack human beings. These are the head-louse (*Pediculus capitis*), the body louse (*P. vestimenti*), and the crab (*Phthirius inguinalis*). When once these insects appear they can only be exterminated by thorough watchfulness and cleanliness. Children (who are frequently attacked by the head-louse) require their hair to be frequently combed, as all lice are prolific breeders. Many children obtain lice at school by hanging their hats up near those of others. The head-louse seems to prefer the region just above the ears, and in such places their eggs or "nits" may sometimes be seen in hundreds. On very dirty people the eggs may sometimes be seen thickly sprinkled like sand throughout the hair. On examination these eggs will usually be found to be empty, as they will stick to the hairs long after the young are hatched.

The body-louse is seldom found on any but very dirty people, although anyone is liable to be attacked by it. It is a larger and thicker insect than the head-louse, and appears to live by preference on the under-clothes, into any fold of which it will creep, and from which position it will suck up the blood of its victim. It is best, therefore, to boil any clothes which harbour it.

The crab prefers the pubic regions, and causes intolerable itching. A person may be absolutely free from this pest, and yet within a fortnight be nearly driven mad by them, and on examination find them swarming on him. They are fortunately very readily killed by the use of mercurial or "blue" ointment. All lice are provided with strong claws for hanging on to hairs, but in the crab the claws are enormously developed.

Cattle Lice.

The short-nosed cattle-louse (*Haematopinus eurysternus*) and long-nosed or calf-louse (*H. vituli*) occur in Tasmania. The former is often found on cattle in poor condition, whilst the latter is usually seen only on calves, on which, however, it sometimes occurs in thousands. The biting-louse (*Trichodectes scalaris*) also occurs in Tasmania.

Professor Osborne, in speaking of remedies, says, "The main reliance of veterinarians seems to be stavesacre. Mr. Tenney recommends the seed of common larkspur steeped, and the animal thoroughly washed with the liquid. He says 'I have known one application to destroy every insect and egg; two will suffice if done thoroughly.' Of course, this and the stavesacres are nearly identical, both plants belonging to the genus *Delphinum*. Washes of carbolic acid soap or of tobacco infusion are also effectual, but washes of any kind are, of course, illy adapted to use in midwinter, the time when there is frequently most necessity for treatment. Mercurial ointment, sulphur, or tobacco-smoke, kerosene and lard, or kerosene emulsion, road-dust, ashes, &c., may be resorted to, according to the circumstances. Infested animals should, if possible, be placed apart from the others, and much trouble may be saved by this precaution."

Horse Lice.

The sucking horse louse (*Hæmatopinus asini*) and the biting horse louse (*Trichodectes pilosus*) are both troublesome to horses. For remedies, see under cattle lice.

The Pig Louse.

This (*Hæmatopinus urius*) is a very common parasite of the pig, to which animal it confines its attacks, and as with many other species, it is most abundant on animals in poor condition. It is the largest species known to occur in Tasmania. For remedies, see under cattle lice.

The Sheep Louse.

This louse (*Trichodectes sphærocephalus*) is sometimes troublesome to sheep, but it is not usual to specially treat for it in Tasmania, as the dipping for sheep-tick destroys it.

Bird Lice.

All kinds of birds are attacked by lice, several species being known to attack the fowl, duck, goose, pigeon, &c. A few attack many kinds of birds, but most are confined to one species of bird, or to allied birds. Some feed on skin and feathers, and others require blood for their nourishment.

Lice and mites are often the cause of poor condition of poultry, and young chickens are often killed by them. To prevent their attacks the fowl-house should be periodically cleaned out, and lime-washed, sulphur being mixed with the lime; sulphur, or pyrethrum, should also be scattered about the fowl-house or scattered in places where the birds are in the habit of having dust-baths. Woodwork should occasionally be painted with kerosene, and the material of nests constantly renewed, and the old material burnt.

Fowl Mite.

This mite (*Dermanyssus gallinæ*) is probably everywhere the most common parasite of the fowl. It is very small, and of a greyish colour, but when full of blood is reddish. It feeds principally at night time, during the day hiding in crevices or under the material of nests. With sitting-hens it is often very troublesome.

Mites of Birds' Nests.

The nests of sparrows and starlings, when built in houses, are often the cause of serious annoyance. On tearing such nests to pieces over white paper, they will usually be found swarming with several kinds of mites. These mites frequently wander from the nests, and passing through cracks in walls and ceilings will sometimes attack people in the rooms, causing intolerable itching, especially at night time in spring. Pigeons and canaries are also attacked. The most annoying of these mites (*Dermanyssus avium*) is closely related to the fowl mite.

Follicle Mites.

There are at least two kinds of these in Tasmania: the follicle mite of man (*Demodex hominis*), the curious little creature that causes "black heads" on the face; and the one of the pig (*D. suis*). The former seldom causes any inconvenience beyond a slight amount of itching at times, and carbolic soaps will readily free the skin from them; but the one of the pig is occasionally serious, large patches of the skin being affected to such an extent that the pig is reduced in condition and its selling-price lowered. On removing the skin numerous small whitish nodular spots are to be seen, each spot being about one-fourth the size of a grain of wheat, the spots being sometimes so thick as to cause the skin to appear speckled; and on examination each spot will be seen to have a minute opening.

Mosquitoes.

More attention has been paid to mosquitoes of recent years than to any other insects, and it is now well known that they are largely instrumental in the distribution of filarian worms (minute blood parasites), malarial and yellow fevers, and other tropical diseases, and in some parts of the world a continual war is being waged on mosquitoes (more especially by destroying their larvæ), with the result that fevers have been greatly reduced. In Tasmania no cases of disease have been traced to mosquitoes as yet, although it is easy to conceive of a disease being transferred from one person to another by such means.

Mosquitoes breed very rapidly. The female lays her eggs in a boat-shaped mass on the surface of still water; the eggs hatch out in about a day, and the larvæ then take on their well-known form of "wrigglers," which live, head downwards, at the surface unless disturbed. In two or three weeks they become full-fed, and change to pupæ, which live tail downwards. The pupæ, although they consume no food, are fairly rapid in motion when disturbed. They remain in the pupal stage for a few days, and then change to the mosquito form.

The larvæ or wrigglers feed on decaying vegetable matter, but the winged mosquitoes are mixed feeders. As a rule they feed on vegetable juices, but all animals are liable to be attacked by them, and even some insects. One naturalist records mosquitoes as destroying large numbers of butterfly pupæ in South America.

Mosquitoes breed in quiet and stagnant waters, and they cannot thrive in swift running streams. Swamps and ponds are their favourite breeding-places, but tanks, old buckets, and tins thrown aside as useless serve as breeding-places for them on occasion, and in the drier parts of the world people are often troubled by mosquitoes, when a little attention to their drinking-water would prevent these pests from breeding. A thin film of kerosene on top of a tank of water would destroy all insect life in it, and the water would not be affected in taste if drawn from below.

Mosquitoes can be prevented from biting by rubbing the exposed parts with oil of lavender, eucalyptus, or almost any essential oil. The bite frequently causes mild blood-poisoning, and itching lumps are raised, the pain of which

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can be greatly lessened by rubbing with the half of a raw onion.

It is only the female mosquito that bites and hums.

March Flies.

Under this name in Australia we have a group of flies belonging to the *Tabanidæ*, many of which attack man and domestic animals. They have often been known to bite a man through his clothes, and even through his boots. They are mostly of large or fairly large size, and rapid in flight. In other parts of the world the *Tabanidæ* are sometimes known as "breeze" flies or "gad" flies, and occasionally, but erroneously, as "bot" flies. The most common species in Tasmania is one known as *Tabanus remotus*. Its body is about half an inch long, but it measures rather more than an inch across the expanded wings. It is of a dark slaty-grey colour, variegated with paler grey. In many parts of Tasmania, and expecially in late summer, hundreds of these may attack a man in the course of a day, but as they are very bold in their attacks, they are easily killed. Horses do not like them, but are not terrified by them as they are by bot flies.

The Biting Stable Fly.

This is the name given to a fly (*Stomoxys calcitrans*) which much resembles the common house fly, but has the tongue developed into a horny process, with which it readily pierces the skin of the horse and other animals. It is also not at all uncommon for it to bite a man, and it has been blamed as one of the causes for distributing anthrax. It is very common about stables and butchers' shops, where it may often be seen resting, gorged with blood.

The Bed Bug.

This (*Acanthia lectularia*) is another disgusting insect, with which every place is liable to become infested at one time or another, and which, owing to its habits, may be in a house some time before it is noticed. Once established, especially in wooden houses, it is often difficult to be got rid of.

The eggs are laid in clusters close together, and are very beautiful objects for the microscope. The larvæ on hatching out are not much different in appearance (except as to size) from the fully-grown insects, and they have the same disagreeable smell.

The bed-bug is nocturnal in habit, remaining concealed during the day in the joints of bedsteads, in cracks of the floors and walls, &c., into which its narrow flat shape allows it to creep in comfort. Hence, in striving to get rid of the pest it is necessary to direct attention to such places. Sprinkling insect powder or pouring boiling water about the framework of the bed, especially at the four corners, and on cracks of the floors and walls, is a good plan; but whatever method be used, it will often be found necessary to repeat it, and a constant outlook for the re-appearance of the pest is required.

Of late years a good many houses have been fumigated with hydrocyanic acid gas for this pest, the gas being an absolute cure for this and all other domestic insects (also for mice), providing the house can be made comparatively air-tight. The gas, however, is such a deadly one that very great care must be taken with it.

Scorpions.

These nasty little creatures are sometimes seen in houses in Tasmania, especially in wooden ones, or where wood is largely used for firing. Fortunately they are never so large here as in the tropics, but the sting from one is sufficiently painful, although not dangerous. Scorpions have nippers, but although they can bite with these, they can inflict very little pain with them; the poison gland and sting are in the enlarged terminal segment.

Ammonia is useful for relieving the pain of any sting or bite, but if this is not handy a raw onion can be cut in halves and rubbed on the affected parts.

Centipedes.

These also are to be seen occasionally in Tasmanian houses, but they are all comparatively small. A Tasmanian centipede 5 inches in length would be regarded as a very large one, but in Queensland centipedes over 1 foot in length and of proportionate width have been seen. Centipedes do not sting with the tail, but bite with jaws, these being developed from the second pair of legs.

Spiders.

Many kinds of spiders are to be seen in houses, from the curious daddy long-legs with long thin legs and small grey body to the large, almost black, spider which spins webs in corners of outhouses, and rushes out from a tunnel on to any unwary victim. In wooden houses at night time a large spider (often erroneously called a tarantula) may often be seen spread-eagled on the ceiling. All these spiders can bite, and the bite is sometimes painful, but in Tasmania only one kind of spider is known to be really dangerous to life, and that only when the person bitten is in very low condition, although it has occasionally caused the loss of a hand or finger. This spider (*Latrodectus hasseltii*) has a deep black body with a bright red stripe on the hind part, and the legs long and thin. In New Zealand it is known by the Maori name of "Katipo." Anyone bitten by this spider should consult a doctor as soon as possible. In Tasmania it is, fortunately, rarely seen in the house.

The House Fly.

The maggots of the common house fly (*Musca domestica*) undoubtedly serve a useful purpose by causing decaying animal and vegetable matter to disappear more rapidly than it otherwise would; but apart from this, flies can only be regarded as pests. The most common food of the maggots is stable

manure, consequently places that are near stables often swarm with flies, but almost any decaying vegetable or animal substance will attract them in large numbers.

The eggs are narrow and curved, and in warm situations hatch in a few hours. The maggot, as soon as hatched, commences feeding, and never leaves off till about to pupate. This usually takes place in a week, but may be hastened or retarded by hot or cold weather. In the summer the pupal stage may last from four to eight days; in the winter it may last for several months. The flies themselves are very short-lived. In ordinary summer weather the entire development of a fly from the egg to the winged insect may occupy less than a fortnight; a few hot days following after a cold spell will bring them out in swarms.

In the open in Tasmania it is seldom troublesome, but in many parts of Australia it is a great nuisance, lighting on the face to suck up the perspiration, and getting into the corners of the eyes. In the Australian bush it is quite a common sight to see a man's back entirely covered with flies, a few of which will every now and then fly to his face or other exposed parts. In such places fly veils are often worn, or a ring of bits of corks will be worn dangling from the hat. Veils are also often used to protect horses against flies.

There are many kinds of flies to be seen in the house, especially in summer, but the common house fly can be distinguished from all of these by its habit of resting at night with its head downwards. In the house they are a source of constant worry, spotting glass and furniture, dropping into the milk and tea, and worrying by alighting on the face, especially of the sick. It is largely owing to them that typhoid and other diseases are distributed: a fly, for instance, lights on matter passed from a typhoid patient; soon afterwards, perhaps, it suicides in a cup of tea or in the milk-jug, either in the same house or in that of a neighbour, giving every chance for the disease to spread. Sandy blight, so common in many parts of Australia, is largely due to these little pests.

In the United States many experiments have been carried out with the view to preventing flies from breeding in stable manure, and it is now recommended that, where possible, this should be thrown into a closed box every day and sprinkled with kerosene or crude petroleum, thus effectually preventing the flies from breeding.

There are certain patented powders which, if sprinkled at the bottom of the glass of a window, will destroy all insects which touch it; there are also patented substances which, if burned in a room, will destroy all the insects in it. Papers, both sticky and poisonous, are too well known to need further mention.

Almost all the common flies in a house can be enticed outside by a very simple plan. This is simply to draw the blind down till near the bottom, leave the bottom of the window down, but the top slightly open. The flies will all crawl or fly to the top of the window, and finding it open will fly outside. Blowflies, however, will not do this to the same extent as the smaller kind.

Blowflies.

Two species of blowflies (*Calliphora oceanica* and *C. villosa*) are very common in houses in Tasmania. There are few more disgusting insects than blowflies, and though normally we must suppose that the food of their maggots consists of putrid matter, the flies will often lay their eggs on fresh meat; in some places they are even so bad that they will hover round pots in which meat is being cooked. In the house they will lay their maggots on any meat and on almost any kind of cooked vegetable.

Both of the abovenamed kinds are to be reared from the blown wool of sheep. The maggots are especially noticeable after rains. Ewes and lambs are most commonly attacked, the wethers usually escaping. They are most numerous in the hind-quarters, where they work down to the base of the wool, sometimes swarming in thousands and causing the skin to become hard and to crack, and through the cracks they will often attack the flesh itself; in consequence, large patches become festering sores, the sheep bite and scratch themselves, and the wool is reduced both in quantity and quality. They will also sometimes crawl up the hind-openings into the body, and kill the sheep by the intense irritation caused. Sheep are also sometimes killed by maggots swarming in shear-cuts.

Cockroaches.

Once these insects, of which there are two common domestic species (*Periplaneta orientalis* and *Ectobia germanica*), appear in a house, it is often difficult to get rid of them. They move about at night, and are attracted to warm places, such as stoves, ovens, &c.; consequently it is usually in kitchens that they are noticed. One of the best methods of destroying them is to burn sulphur, the fumes of which will kill, or at least stupefy, almost any insect. To render the fumes thoroughly effective all doors and windows should be closed, and the sulphur (to which a little saltpetre may be added) placed in the middle of the room on a dish of live coals. But as the cockroaches are often only rendered insensible by the fumes, they should be swept up and burned, otherwise the effect of the fumes is liable to pass off.

Sprinkling hellebore or pyrethrum in the places they frequent will often drive cockroaches away.

The Cheese Maggot or Jumper.

This is the larva of a small blackish fly (*Piophila casei*) which may often be seen on cheese, and which is now almost cosmopolitan. The fly has a long ovipositor which it thrusts, with the aid of its abdomen, into cracks of cheese to deposit its eggs. The maggot or jumper is small, thin, of a pale yellowish colour, and with a black head. When disturbed it has a habit of doubling itself into a hoop, and then, suddenly releasing itself, springs or jumps for some distance. Thousands may often be seen in affected cheese. The places where the maggots are present are marked by watery-looking spots, and the outer portion of the cheese gets dry and hard, and is very liable to split. The cheese when whole may be protected from

attack by washing it with strong brine, or if cut, with fine mosquito-net or muslin. This fly occasionally attacks bread, and rancid fat and bacon are frequently attacked.

Curiously enough, these maggots and the cheese-mites are actually relished by some people.

The Cheese Mite.

Cheese is often attacked by this minute creature (*Tyroglyphus siro*), and although very small, it breeds so rapidly that a cheese may be soon destroyed. When attacked it becomes crumbly and covered with a sort of greasy dust, consisting of fragments of cheese, mites, and their cast skins and excrement. On examining the dust with a magnifying lens the mites may be seen in countless thousands. Dried figs, dates, currants, raisins, sugar, flour, and meals are all liable to attack. Five tons of Indian bran landed in Hobart in 1903 were so heavily infested by these mites that probably half a ton of the weight was made up of them.

An allied but somewhat larger mite (*T. longior*) does similar damage to the cheese mite, but is not quite so common.

Whole cheeses may be protected from attack by being washed with strong brine, but should the mite appear in a cheese-house, all the cheeses should be removed and washed, and the room cleaned out with hot water or steam, care being taken that all crevices and places of concealment are thoroughly scalded. The fumes of burning sulphur will destroy these mites, but such fumes are apt to destroy many food products as well.

Clothes' Moths.

Clothes folded and placed away in drawers are often partially or entirely destroyed by the larvæ of clothes' moths. Of these there are many kinds, some of which are very destructive to woollen products, and others feed indifferently on woollen and cotton goods, skins, stuffed birds, &c. They may be kept away from drawers by placing in these naptha (or moth) balls or camphor, but if camphor is used several pieces in each drawer will be required, as it does not seem to have such a deterrent effect as the naptha balls.

The Silver Fish.

This is a small and degraded Neuropterous insect (*Lepisma saccharina*) closely covered with glittering silvery scales. It feeds on almost any dried substance, but appears to prefer books, pictures, and clothing. It may often be seen on papered walls, in drawers and cupboards, &c.

Where it can in safety be done, the best manner of poisoning this insect is by setting traps of poisoned sugar. In living-rooms, sprinkling the backs of pictures, books, &c., with insect powder will destroy them, and moth balls will keep them away from clothes.

Psocus.

This is a very small insect (*Atropos divinatoria*) which may often be seen crawling about in cupboards and drawers, especially where dust has been allowed to accumulate. It is flat and grey in colour, and has often caused alarm, owing to its resemblance to lice; it is a quite harmless insect, however, except under very exceptional circumstances.

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The Bacon Beetle.

Bacon in Tasmania is sometimes attacked by the bacon beetle (*Dermestes lardarius*) and its larvæ: the latter are curious brown hairy creatures, rather more than half an inch in length. The beetles themselves are about one-fourth of an inch in length, blackish, but with a grey band across the middle. Once the bacon is seen to be attacked, it should be frequently examined, and jarred on the floor to dislodge the insects.

NIGHT-FEEDING INSECTS.

Many insects which attack fruit trees feed only at night time, during the day remaining concealed underground at the foot of the tree attacked. The majority of these insects are wingless beetles and caterpillars of various moths. Most of these can be prevented from climbing the trunks of the trees by placing around each of these a bandage soaked in tar; no insect will willingly pass over a freshly-tarred bandage. Many also will feed on poisoned mash, if there is some at the foot of the tree. Large numbers of them can be obtained in daylight by hunting through the first inch or two of soil at the roots of the trees. It will usually be found that young trees on newly cleared ground are attacked more severely than on long cleared ground, especially when (as the majority of them are) the attacking insects are wingless beetles.

INSECTS IN FALLEN FRUIT.

Frequently when fruit has fallen to the ground insects may be seen feeding on it, and not infrequently these are blamed as the cause of the fruit falling. As a matter of fact, many small beetles and flies are never seen on healthy fruit, but as soon as it commences to decay they simply swarm on it. The ferment flies and their maggots may often be so seen. Of the beetles, the commoner kinds seen on fallen fruit are *Carpophilus hemipterus*, *C. aterrimus*, *Microchætes scoparius*, *Lacon caliginosus*, several species of *Brachypeplus and Anthicus*, and many species of *Staphylinidæ*. The soldier bugs may sometimes be seen in immense numbers on fallen apples. Several species of *Acaridæ* or mites and of millipedes are also to be seen in fallen fruit.

PESTS OF CITRUS FRUITS.

So few oranges, lemons, and other citrus fruits are grown in Tasmania that it has not been considered necessary to deal at length with the pests which attack them, but the following have been noticed:—Melanose, orange aphis (*Siphonophora citrifolii*), black scale (*Lecanium oleæ*), and soft scale (*L. hesperidum*). The leaves are often seen covered with fumagene, a blackish fungus which lives on the honey-dew given off by different kinds of scale insects and aphides. As yet the red scale (*Aspidiotus aurantii*), probably the most injurious of all the scale insects of the orange, does not appear to have established itself in Tasmania.

FUNGI AND BACTERIA.

Black Spot.

In Tasmania, and probably in all the world, the most serious fungus disease of the apple is the black spot or apple scab (*Fusicladium dentriticum*); an allied fungus (*F. pyrinum*) attacks the pear, and is also known as black spot (sometimes, however, it is known as the Windsor pear blight). The methods of attack by both these pests, and the appearance of the attacked fruit, is very similar, so that for all practical purposes they may be regarded as one.

The black spot attacks both leaves and fruit (and to a certain extent the bark), the principal damage being done to the fruit. The growth of the black spot is, briefly, as follows:—The spores (or seeds), after setting on the fruit, send out thin roots (known as mycelial threads), which find their way beneath the skin; here they start growth (the skin presenting a greenish-yellow appearance over the parts attacked), and in time rupture the skin and form spores; these are so small that it requires a high power of the microscope to render them visible, but they are in such immense numbers as to form small sooty spots, which gives the pest its well-known appearance and name. The skin at these spots is killed, consequently, when the young apple starts growth it cannot grow uniformly, and frequently splits at the spots.

The leaves are also attacked, and, in the case of the pear, frequently blister and split; with the apple they seldom split, but appear as if rubbed with soot, and are marked with greenish-yellow patches. The growth of the trees themselves is also checked, and a badly-attacked tree can be distinguished some distance away.

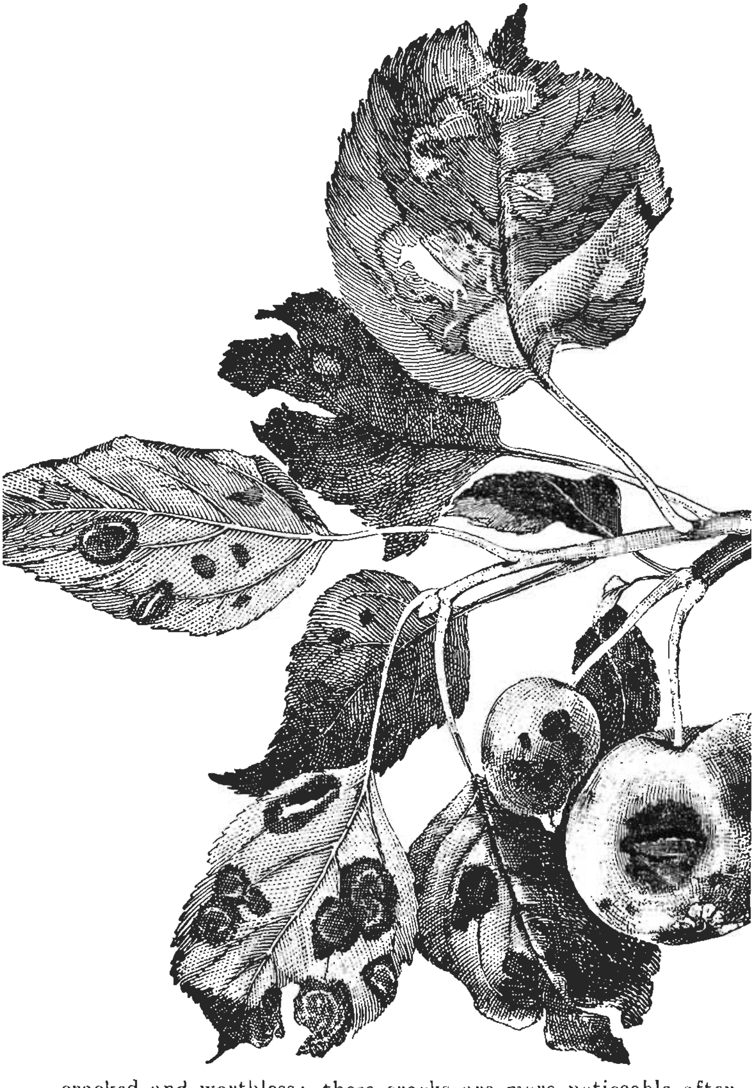
The pest is worst in damp, low-lying situations, in gullies and hills where fogs and mists are frequent, and districts which have frequent rainfalls (especially of a fine showery nature); consequently, districts like the Huon, the Kangaroo Valley, and some of the valleys about New Norfolk, are especially liable to its attacks.

A cold rain does not seem to affect it much, but continual showers or several hot days following after rain cause it to spread like wildfire. It is largely for this reason that it is much more destructive during certain seasons than others.

The spot is capable of attacking trees all the year round (small apples of the second crop hanging on trees in the winter after all others have been picked may often be seen to be attacked by this disease), but appears to be most active just about the time when the trees are bursting into bloom and the young fruit setting, and later on during the late summer and early autumn rains. It is also capable of spreading in cases after these have been packed. When it spreads in cases it appears as smears or blotches rather than as more or less rounded spots.

Apples are affected by the spot in different ways, according to their state of growth and according to the variety. Soon after, or even before, the petals have fallen, spots may frequently be seen on the flower-stalks, and these spots will almost invariably cause the apple to fall before it becomes the size of a pea; so many are occasionally destroyed that very little fruit is left on a tree. Afterwards, from the time fruit is the

size of a marble, the spot will seldom cause it to fall; but, wherever it appears, arrest of development takes place, the unaffected side growing normally, whilst the spotted side is shrunken. With certain varieties the fruit becomes badly



cracked and worthless; these cracks are more noticeable after a shower, the sudden access of moisture to the tree causing a rapid swelling to take place, and the surface at the black spots being hard and lifeless cannot expand, and, in conse-

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quence, splits. The splits will sometimes extend right around the apple, and will frequently leave the pips exposed. When fruit is attacked when nearly full-grown, it seldom splits (or the splits when present are always very small), but the spots are frequently so numerous as to cause it to be reduced in value. Splitting of fruit, however, is not always caused by black spot, as there are several other reasons why it sometimes splits.

Pear trees, when attacked by the spot early in the season, will sometimes lose their entire crop, the ground beneath them being littered with fruit from the size of peas to that of large marbles. As a rule, on the pear, large patches are covered, either on the side just below the middle or near the crown; with many varieties the pears become badly distorted so as to be either quite worthless, or at least greatly reduced in value; but in a number of them the spots much resemble those seen on apples. On the apple the disease is almost invariably present in small, round spots, which, however, may become joined together as they grow; they are not generally distributed, but usually in small clusters on the side of the apple facing the prevailing wind. Sometimes hundreds of spots may be counted on a single apple.

The Sturmer Pippin, if attacked early in the season, is generally destroyed, but if attacked when a fair size seems capable of throwing off the disease, although not escaping a slight distortion. This is also the case with a number of other hard-skinned varieties.

Insects are affected to a certain extent by winds and rains, but fungi are almost wholly dependent upon them. An insect, once exterminated from an orchard, usually takes considerable time to re-establish itself in that orchard; but it is absolutely impossible to guarantee that an orchard shall be free from black spot. Hence a spray for a fungus disease and a spray for an insect are essentially different (it is true that some fungicides are also useful against insects; but this is seldom the case), since a spray for an insect in nearly every instance should be rapidly effective to be of use, whilst that for a fungus disease should not only be effective at the time of application, but should be of such a nature that it will stick for some considerable time, and still be effective. There are many substances known that will kill fungi; but no cheap mixtures are known that are so fatal to black spot and will last for such a long time as the Bordeaux and Burgundy mixtures.

The principal mixtures used against black spot are:—

Bordeaux mixture.
Burgundy mixture.
Sulphur, lime, and salt.
Eau celeste.

Bordeaux mixture not only acts as a fungicide, but kills all mosses and lichen on trees, and that portion of it that falls to the ground acts as a manure. This, however, is also true of the sulphur, lime, and salt mixture.

Of considerable importance to an orchard that is troubled with black spot is to see that it is sufficiently limed and well drained. Lime is a highly necessary food for apple trees, and, if the soil is at all deficient in it, the trees will be predisposed to disease. Drainage is also very necessary; over and over

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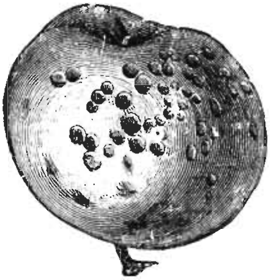
again in undrained orchards it has been noticed that trees growing on the top of a small elevation are freer from spot than those surrounding them; and, in nearly every instance, the part of any orchard that is most badly spotted is that lying in a hollow, where there is no natural get-away for the water.

"A simple way of ascertaining if soil contains lime is to take a teaspoonful of soil and stir it into a glass of water to which ammonia has been added. Set it aside for a few hours, then, if lime be present, the liquid which remains at the top will be nearly colourless; but where lime and magnesia are lacking in a soil the liquid has usually a dark-brown or black appearance, the intensity of colour depending upon the amount of soil taken, and, of course, upon the lime."

The apples which are most liable to black spot in Tasmania are the Scarlet Nonpareil (commonly called Scarlet Pearmain), New York Pippin (or Cleopatra), Golden Reinette (commonly called Adams' Pearmain), Newtown Pippin, Shepherd's Perfection, Crofton Pearmain, Hoover, Duke of Clarence, Crow's Egg, and Pearson's Plate. The pears most liable are Napoleon, Marie Louise, Louis Bon of Jersey, and Beurre Bosc.

So far as is known, the black spots of the pear and apple occur only in those fruits; of course, their spores are blown on to all kinds of trees or shrubs, but they do not reproduce there. It is true that many kinds of black and brown diseased-looking spots are to be seen on trees in the bush, and on other trees, shrubs, and vegetables in the garden; but there are some hundreds of different kinds of fungus diseases which look much alike until the microscope is brought to bear upon them.

Bitter Pit.



Bitter Pit.

The disease (next to black spot) most troublesome in Tasmania is bitter pit; it affects different apples in different ways. It shows outwardly in the New York as brown spots (sometimes, however, of a bright red colour), and when the flesh is cut into, it will be seen that it is of a brown spongy nature, this sponginess sometimes extending to the core; these portions are bitter (sometimes very much so), and it was for this reason, and for the fact that the outer spots are usually lower than the general surface, that the disease has been called "Bitter Pit." In the Scarlets it is usually only the largest samples that are attacked; the disease in them usually shows as more or less irregular, and slightly depressed, blotches on the skin, often forming a more or less irregular circle about the crown. The affected skin becomes brittle, but is not so bitter as in the New York, neither do the spots extend into the flesh as in that apple. With the Scarlets the apples are never destroyed, though often of unsightly appearance, but the New Yorks are often so badly attacked as to be quite uneatable.

The Sturmer is sometimes rather badly attacked, the spots in that variety being larger than in the New York, but the brown, spongy tissue seldom extends so far into the fruit.

Dr. Cobb says of this disease:—

"I have seen no evidence that would prove the disease to be caused by a fungus. No remedy can be proposed beyond avoidance of the sorts liable to the disease. If a tree showed this disease badly two seasons in succession, I would advise removing it, for, according to my observations, the disease continues from year to year in the same tree. The disease seems to me not very contagious. Apples attacked by bitter pit have poor flavour, and do not keep well.'

Mr. McAlpine says of this disease:–

"The experience of Victorian apple-shippers in regard to 'Bitter Pit' points to the conclusion that, if perfectly sound fruit alone be packed, there will be no loss from development of the disease on the voyage to London. Those kinds which are liable are usually kept some time after picking before packing, and any specimen showing the slightest trace of pitting or spotting is sold right away in the local market, as experience has shown that the longer such fruit is kept the worse becomes its appearance. Too many growers, however, are inclined to think that one or two spots or 'pits' will not affect the price per case appreciably, and therefore pack such fruits, with the result that by the time it reaches London it is merely a mass of pits and blotches."

There appears to be no known satisfactory remedy for this disease, the very nature of which is unknown, although it is supposed to be due to bacteria.

Peach Leaf Curl.

This disease, which attacks a number of stone fruits, but especially the peach, appears in early spring, soon after the buds have burst, and continues almost or quite to December. It causes the leaves to become thickened and distorted, and frequently excessively large, with a pale watery appearance, but often with yellowish and reddish tints. Sometimes only small portions of leaves, and but few on a tree, are affected; at others, the whole of the leaves are badly distorted.

The distorted leaves frequently have "pockets," which range in diameter up to 2 inches. As the disease approaches maturity the leaves lose, to a certain extent, the shininess characteristic of the earlier stages, and become dull. The spores (or seed) when developed cause the leaves to appear "as if covered with frost, or with an exceedingly fine powder." They are so minute and numerous that Dr. Cobb estimates that a single square inch of diseased leaf may bear no less than twenty million spores. Soon after the spores have ripened most of the affected leaves fall to the ground.

Mr. Newton B. Pierce, in charge of the Pacific Coast Laboratory of the United States Department of Agriculture, conducted exhaustive experiments against this pest in the United States, and in the preface to his report says:—"The experiments were conducted under the most varied conditions of soil, climate, &c., in all the leading peach centres of the United States, and it is believed that the recommendations for treatment here given are equally applicable wherever peaches are grown."

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His book extends to 204 pages, with 30 plates and numerous cuts in the text, and can probably be obtained on application to the Department of Agriculture at Washington. His summary, however, is reproduced below: –

"1. Peach leaf curl has a world-wide distribution, occurring in every region in which the peach is grown. In humid localities it is a leading hindrance to peach culture.

"2. The orchard losses from peach leaf curl vary from a small amount of fruit to the entire crop, while in many instances young trees are killed. The national losses from this disease amount to 3,000,000 dollars annually.

"3. Curl is caused by a parasitic fungus known as *Exoascus deformans*, the ravages of which are largely dependent upon the atmospheric conditions prevailing while the trees are leafing out. Rains and cold weather at that time tend to increase the severity of the trouble by favouring the growth of the parasite and interfering with the proper functions of the host. For these reasons orchards near large bodies of water and in low or damp situations are more subject to curl than those in dry regions or in elevated situations.

Peach Leaf Curl.

"4. Most of the spring infections of peach leaves are due to the spores of the fungus, and not to a perennial mycelium, as formerly held: hence the efficacy of sprays.

"5. Curl was first successfully treated in California during the period from 1880 to 1885, the success depending upon the application of fungicides to the dormant trees.

"6. The copper sprays are now found to be more effective than the sulphur or other sprays first used. Of the various sprays experimented with, Bordeaux mixture in the proportion of 5 lbs. copper sulphate (bluestone), 5 lbs. lime, and 45 gallons of water, gave the best results, the equal weights of the copper sulphate and lime being most effective when the mixture is applied shortly before the opening of the blossom buds. When it is desired to increase the durability of a spray by increasing the proportion of lime, the application should be made earlier, or equal proportions of copper and lime should be maintained. The total saving of foliage increases with the increase of copper sulphate when the amount of lime remains constant, but the average saving per pound of copper sulphate decreases with the increase of copper used.

"7. In the treatment of peach leaf curl from 95 to 98 per cent. of the spring foliage was saved by spraying. A net gain of 600 per cent. in foliage over that retained by adjoining

unsprayed trees resulted in the case of several different sprays. Bordeaux mixture, when applied to the dormant tree, increased the weight and starch-producing power of the leaves, and the sprayed trees showed a great gain over the unsprayed in the number and quality of the fruit buds they produced for the following year, the gain in the number of spur buds being over 100 per cent. in some cases. The lower limbs of sprayed trees showed a marked gain over those of unsprayed trees, as compared with the upper limbs, in both the number of fruit buds and lateral shoots they produced.

"8. The average value of the fruit per tree in rows treated with the most effective Bordeaux mixture ranged as high as $6·20 above that per tree in adjoining untreated rows, or the equivalent of a net gain of $427·80 per acre where trees are planted 25 by 25 feet. Over 1000 per cent. net gain in the fruit set has resulted in the use of some of the more effective sprays.

"9. The trees should be sprayed each season, as the experiments proved that treatment one season will not prevent the disease the following year. Spraying should also be done even though the trees may not be expected to bear, as the loss of the crop of leaves is shown to result in as great a drain upon the trees as does the maturing of one-half to two-thirds of a crop of fruit.

"10. The work demonstrates that peach leaf curl may be cheaply and easily prevented in California, in Western Oregon, and Washington, and along the east shore of Lake Michigan, where curl causes great loss, as well as in all other peach-growing sections in the United States.

"11. The copper and lime sprays are less injurious to the trees than those composed of sulphur and lime. The use of lime in winter sprays has proven an advantage in enabling the workmen to see their work and complete it with greater thoroughness than would otherwise be possible. A proportional increase of both lime and copper sulphate is recommended for wet regions, and for very wet localities a second winter spraying is advised.

"12. Cyclone nozzles with lateral or diagonal discharge are best adapted to the work.

"13. *The proper time for winter spraying and the number* of applications depends to some extent on the locality, season, &c., but active sprays are likely to do most good if applied from one to three weeks before the opening of the blossoms in spring. The proper time to apply sprays for the prevention of curl is in dry, calm weather, and during the middle of the day, in order to avoid dew or frost upon the limbs as much as possible.

"14. *As nearly 200 peach and nectarine varieties* were considered with a view of determining their susceptibility to curl, it was found that very few were wholly free from the disease, and that some were very subject to it. Some of the choicest varieties, as the Elberta and Lovell, are seriously affected, but it has been demonstrated that a single winter treatment will prevent the disease upon even these varieties. It may thus be fairly claimed that the spraying methods recommended will save to the peach industry some of its finest

varieties, as well as result in the saving of foliage and crops already indicated."

Shot-hole.

This is a fungus disease which makes small holes in the leaves of the apricot, causing them to appear as if riddled with shot; the fruit is also attacked, and becomes red and

Shot-hole of Apricot.

scabby. The plum, peach, nectarine, almond, and cherry are also attacked. The disease can be prevented to a great extent by spraying the trees with Bordeaux mixture, just before the buds burst; later on the fruit can be protected with ammonia-carbonate of copper; or with very weak Bordeaux mixture.

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Powdery Mildew or Fire Blight.

This is a fungus disease (*Podosphaera oxyacantha*, frequently known as *P. kunzei*), which sometimes is very destructive to nursery stocks and to the young shoots of bearing apple trees, and to which the New Yorks and Stone Pippins appear to be especially liable. It is often seen on the hawthorn. The affected parts, when fresh, have a mouldy appearance; the leaves do not expand properly, but instead become brittle, split, and fall before their proper time, so that the shoots have a withered or burnt-up appearance. The affected parts are readily seen, and in bearing trees should always be cut out. Various remedies are given for this disease, the principal being the Bordeaux mixture, but it is seldom sufficiently destructive to full-grown trees to render such necessary. The fruit does not appear to be attacked.

Powdery Mildew or Fire Blight.

Mouldy Core of Apples.

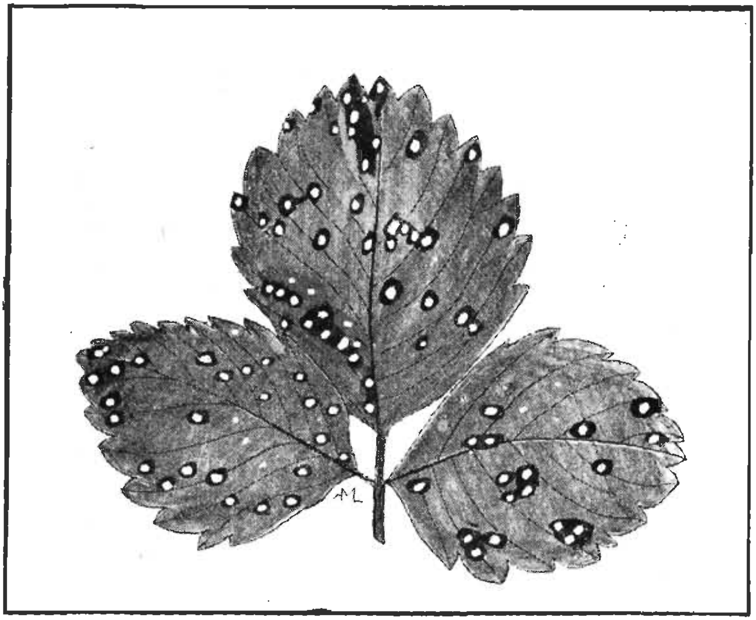
This is not a disease of the apple itself, but is liable to occur in many varieties; it usually appears, however, only in those having a large central chamber. One end of this is close to the bottom of the calyx tube, and the space between the two often splits across, so as to allow the spores of mould to get inside, and these soon grow, and so cause the whole of the inside to become mouldy. The New York or Cleopatra is especially subject to it.

Grape-vine Oidium or Mildew.

The grape-vine is especially subject to the attacks of a mildew (*Oidium tuckeri*), which causes the bunches to appear as if covered with dirty flour; the berries afterwards turn brown and split (if not taken in time it is not at all uncommon for every bunch to be destroyed). The canes are also attacked, the disease appearing on them in dingy, brownish patches. The almost universal, and certainly the best, remedy for this disease is sulphur, dusted on the vines in early spring. Special bellows are made for this purpose.

Strawberry-leaf Spot.

The strawberry all over the world is attacked by a fungus disease known as *Sphaerella fragrariæ*. It causes numerous



Strawberry-leaf Spot (reduced).

small, more or less round, dark-brown spots to appear on the leaves, and in time the centre of each spot becomes dead and withered. In some parts of the world, and with some varieties, the plants are greatly injured. In Tasmania it is to be seen on almost every strawberry plant grown, although but few appear to be seriously injured by it.

Professor Galloway says of this disease: "It is known that this disease usually causes the greatest injury by attacking the new growth, which appears directly after the fruit is harvested. At this period the old leaves contain numerous spores, and it is these that affect the young leaves. To prevent this the prac-

tice of burning over the plants just after the fruit is gathered has been followed with success, the young plants usually starting up and growing thriftily after the treatment. The complete destruction of the old leaves is usually effected by mowing the plants, allowing the foliage to dry for a day or two, and then burning."

It will also be found that the Bordeaux mixture (so useful in Tasmania against black spot of the apple) is very useful in combating this disease.

Bacteriosis of the Walnut.

The walnut is sometimes attacked by this troublesome disease, for which, as with so many other diseases of bacterial origin, there appears to be no known satisfactory remedy. In the *Agricultural Gazette* of New South Wales Dr. Cobb says:—

"One of the worst diseases known to this tree is of bacterial origin. In other countries it sometimes carries off the bulk of the crop. It attacks especially the fruit and leaves, and the chief characteristic of the disease is the appearance on these parts, often early in the season, when the disease is likely to do the most damage, of soft black spots, which affect particularly the new growths and frequently kill the young nuts. Nuts attacked later in the season, when the shells have partly formed, do not suffer so severely, but their husks are attacked, and their proper ripening is prevented.

"No satisfactory treatment is known, but it is stated that a winter treatment with full strength Bordeaux mixture appears to have done good. As the disease winters in the husks, it is advisable to give them special attention, not allowing them to accumulate and rot under the trees. It is comparatively easy to adopt methods of culture that will allow of the burning of husks and foliage, and, in my opinion, this should be done."

Root-rot.

In Tasmania, as elsewhere, fruit trees will sometimes die off without any apparent reason. In some cases, no doubt, the fault rests with the orchardist himself, whilst in others they may have been killed by the attacks of a semi-transparent mite that feeds on the bark of the roots, and causes it to become soft and spongy. In the majority of cases, however (except when the reason is want of, or improper, drainage), and especially when the trees are near an old stump or log, the trees are killed by the underground roots or mycelia of a species of mushroom or toadstool. Many trees have been so killed even when no mushroom or toadstool is close at hand.

"Pourridie," a well-known and severe disease of the grapevine, is caused by such a fungus in damp or badly-drained situations; but many other plants, and particularly apple trees, are also attacked.

In Volume 8 of the *Agricultural Gazette* of New South Wales, Dr. Cobb writes:—"Every year brings me a number of enquiries as to the cause of the death of the whole or parts of trees, generally fruit trees, under peculiar circumstances. A tree in good soil, and hitherto vigorous, suddenly sickens and dies. In such instances we at once suspect one of two causes, namely, insects or some timber-rotting fungus.

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"In the second case (the first dealing with the insects), the death of the tree is usually slower, and the cause is commonly more hidden from sight. The wood of the dead tree, however, on being examined carefully, or compared with healthy wood of the same kind, exhibits the peculiarities well-known under the name of *dry-rot*. The diseased wood is softer and more brittle than sound wood, and differs also in colour, and finally becomes punk and falls to pieces. This deterioration is due to the presence among the fibres of the wood of the hyphæ or vegetative organs of a fungus whose fruit may sometimes be seen either growing out from the bark in the form of "shelves" or "brackets," or in the form of toadstools near the base of the tree. Strange as it may seem, the microscopic "roots," as we may almost call the vegetative organs of these fungi, penetrate long distances into the solid wood of the tree, where, by gradually absorbing and changing the substance of the cells of the wood, they weaken it, and give rise to the well-known appearance of dry-rot. The death of the whole or part of the tree follows as a matter of course."

Of "Pourridie" of the vine Dr. Cobb says:—"If the roots of such unhealthy-looking vines be examined, we find them to be attacked by a white, grey, or brown mould or fungus. The mould, which at first is white, and ultimately changes through grey and brown to black, is composed of numerous microscopic filaments, which are woven together into cords or ribbon-like structures, and these are applied closely to the vine-roots, for it is at the expense of the bark and the wood of the vine that the fungus grows. Not infrequently these cords, composed of fungous filaments, may be traced a considerable distance through the soil, and some of them are found to come to the surface of the ground in order to fructify, or, to put it plainly, though not very accurately, to 'produce a toadstool.' It is by means of a careful study of the different forms of fructification that occur in connection with root-attacking mycelia that Professor Hartig, of Munich, and others have demonstrated that pourridie and similar diseases of timber are due to definite fungi. It is not possible for me to say which of various fungi is most commonly the cause of pouriddie in Australia. There is some reason to believe that *Agaricus melleus* is not the least frequent.

"*Agaricus melleus* is a common edible mushroom or toadstool. It is commonly found growing in the ground in the vicinity of old stumps or rotten standing timber. It is so easily pulled that one not familiar with the habits of fungi would not for a moment suspect that its 'roots' reach not only long distances underground, but high up into the trunks of rotting trees; nevertheless, such is the case.

"When the ripe spores fall to the ground they are incorporated with the soil, either by means of currents of water or by the process of cultivating. If the ground be moist they germinate and grow apace, and as soon as the young hyphæ of these germinating spores get access to roots, they begin to form the white filaments and ribbons which we have described as characteristic of the disease pourridie. The disease spreads slowly from stock to stock."

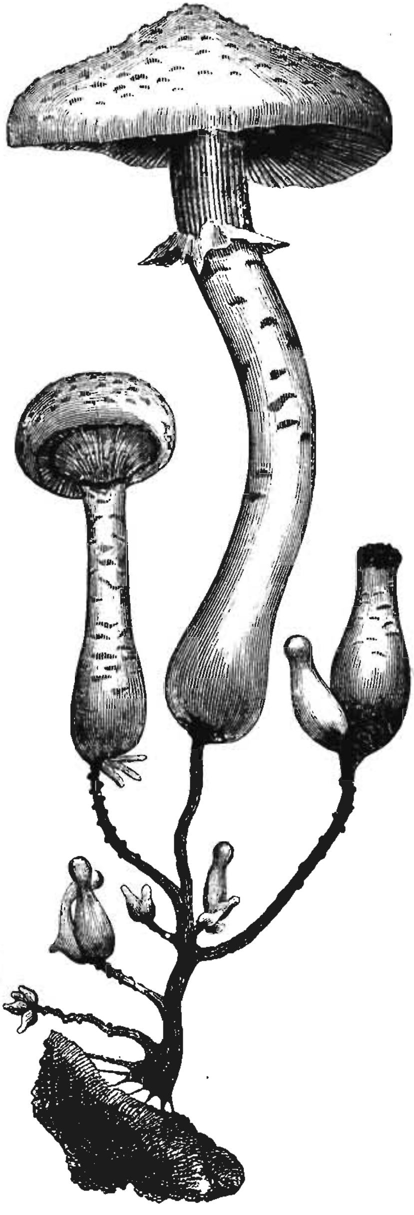
"Where the disease has appeared apply lime liberally and also other appropriate manures. This has the effect of sweetening the soil and improving it in other ways. Keep the place free from rotting and decayed timber. Look out that the drainage is good; this is a most important precaution against timber-destroying fungi. Damp, ill-drained forest is their natural home."—[Cobb.]

A winter treatment which would probably be found to be very useful would be to lay bare the crown of the plant and drench the ground about it with bluestone (sulphate of copper) and water at the rate of 2 ounces to the gallon of water; greenstone (sulphate of iron) would probably also be found useful. Spraying the parts above ground is, of course, quite useless for a root disease.

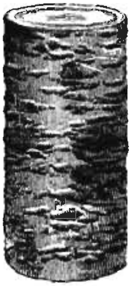
Canker.

Many fruit trees in Tasmania have the bark marked by dark swellings usually of small size, but sometimes covering a considerable amount of surface. This appears to be a disease known as "canker." Of it Dr. Cobb says:—

"The cause of most canker spots is external. Frost, sun, hail, insects, or violent winds first of all injure the bark, and then some parasitic or semi-parasitic fungus attacks the wound thus made, and increases the 'sore' faster than the bark can produce 'healing' tissue. The process goes on from bad to worse until, in some cases, it seems as if there were no limit to the consequent sore or



The Honey Mushroom
(*Agaricus melleus*).
Showing its underground mycelia attached to a fragment of root. Natural size. (After Hartig.)



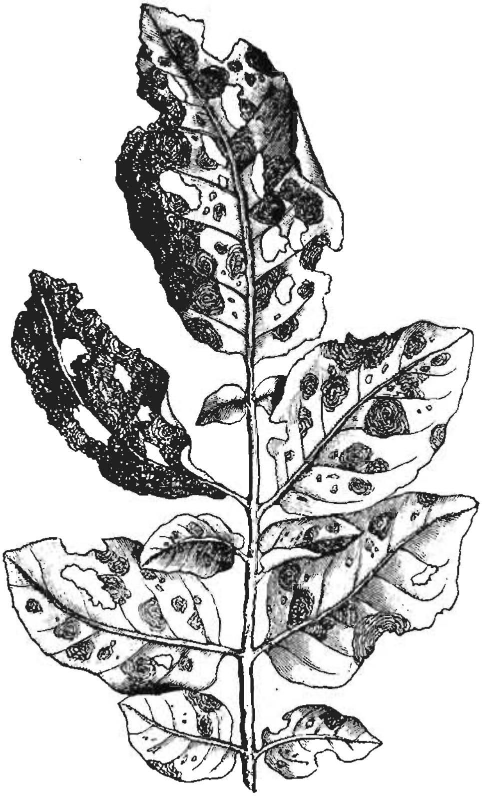
Canker on a Limb of Apple.

excrescence. The disease is generally long drawn out, and in the case of fruit trees is particularly disheartening when severe. Among fruit trees apple trees are probably more subject to canker than any others."

For remedies, he says, "Prune off or cut out the worst cases, and then apply grafting wax to the freshly-made cut. Use sharp tools, and do not cut sparingly. If you do not remove all the diseased bark the disease will remain and continue to spread. Cut away all the bark that appears in the least swollen, discoloured, or in any way unhealthy. Burn the cuttings."

Early Blight or Leaf-spot of the Potato.

This disease *(Macrosporium—or Alternaria— solani)* is com- almost everywhere the potato is grown, and almost everywhere



Leaf-spot of the Potato.

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it has been remarked how suddenly the tubers stop growing once the leaves are attacked. The appearance of the leaves, although somewhat like those attacked by the grubs of the potato moth, is really very different, as they shrivel up and become brittle, and are never joined together.

Professor Galloway says:—"From reliable evidence there is every reason to believe that this disease is often more widespread and destructive in this country (the United States) than the true blight. There is no doubt that the two diseases are often mistaken for the same thing; in fact, it has been the custom for many years to attribute nearly all maladies affecting the potato to the blight fungus.

"The macrosporium disease attacks the leaves, and sometimes the stems, but never the tubers. The disease may appear at any time after the plants are from 4 to 6 inches high. At first the older leaves show greyish-brown spots, the affected parts becoming hard and brittle. The disease progresses rather slowly, the spots gradually becoming larger, especially along the edges of the leaflets. At the end of 10 days or two weeks half of the leaf surface may be brown, withered, and brittle, while the rest is of a pale-yellow colour. Three weeks or a month may elapse before all the leaves succumb, the stems in the meantime remaining green, until they finally perish through lack of nourishment. The tubers stop growing almost as soon as the leaves are attacked, and as a result the crop is practically worthless."

Professor Galloway recommends spraying with the Bordeaux mixture every 10 days in rainy weather, or every 14 days in fine weather. He claims that the spray not only checks the disease, but increases the yield of potatoes by its manurial action.

Potato Scab.

This disease (*Oospora scabies*) and gall-worm are responsible for the condemnation of a great quantity of Tasmanian potatoes in Australia, amounting, in the case of Sydney alone in 1904, to 7576 sacks. It is a disease which is readily communicated to fresh districts or farms by the potatoes themselves, and once in a farm, it has come to stay.

The tubers become very rough, and the affected parts become sunken, so that the skin is suggestive of a bad attack of small-pox. It appears to be a purely skin disease, and the tubers are not checked in their growth by it, as it is usually seen at its worst in the largest samples. The flavour also appears to be but little or not at all affected by it. Still, on account of the roughness of the skin, it is necessary to waste a much greater amount than is necessary with clean-skinned potatoes. If the disease appears when the tubers are growing rapidly it is very liable to cause them to split. Isolated spots are usually about one-third of an inch in diameter, but they frequently become joined together, so that it is not an unusual thing to see fully half, or even more of the surface covered.

Scab is much worse some years than others, as is the case with most diseases.

Once the disease is in the ground treatment of the seed is almost or quite useless; but being a skin disease it is possible to treat affected seed so as to produce perfectly sound potatoes on clean ground. But as the eyes are often destroyed by

the disease, it is necessary to set a larger quantity than would otherwise be needed.

For treatment of seed potatoes affected by scab, three substances have been recommended; viz.: Corrosive sublimate, formalin, and bluestone. Professor B. T. Galloway, of the Washington Department of Agriculture, says:—

"For the treatment of potato scab, a solution of corrosive sublimate has given the best results. This should be prepared by dissolving 2¼ ounces of corrosive sublimate in about 2 gallons of hot water, and, after an interval of 10 or 12 hours, diluting with 13 gallons of water. Very smooth potatoes have been grown from very scabby tubers.

"The potatoes to be planted are simply immersed in the solution for an hour and a half, then spread out to dry, cut, and planted in the usual manner. A large barrel offers a convenient receptacle for the solution. The potatoes may be

Potato Scab.

placed in a coarse sack and suspended in the liquid, care being taken to wash the tubers before dipping, providing they are very dirty. The corrosive sublimate is very poisonous; therefore, it must be used with great care, and kept out of the reach of children and animals. *All treated tubers should be planted.*"

Of the formalin he says:—

"To prepare the formalin solution mix 8 fluid ounces of commercial formalin with 15 gallons of water. Formalin is fully as effective against scab as the corrosive sublimate solution, and as it is far less dangerous it will probably come into general use. In treating seed with this preparation the whole potato should be soaked for two hours in the solution. After soaking, the potatoes may be dried, cut, and planted in the usual way, care being taken not to allow them to become contaminated by coming in contact with bags, bones, or bins where scabby potatoes have been kept. In practice it is found that 15 gallons of either of the foregoing solutions will be sufficient to treat 20 to 25 bushels of potatoes, taking

ordinary precautions, of course, not to waste too much of the fluid as each lot of the tubers is dipped."

The bluestone can be used at the rate of 1 lb. to 10 gallons of water.

In America extensive experiments with manures and fungicides to test their effects upon potato scab were carried out for six years by Byron D. Halsted, of the New Jersey Agricultural Experiment Station. He found that lime, gas-lime, kainit, and ashes actually *increased* the disease, whilst sulphur only seemed to be of use. These experiments were carried out on ground known to be badly infested by scab, and a summary of the results obtained was published, as follows:—

"In soil known to be thoroughly infested with the germs causing potato scab, the fungicidal properties of a considerable number of substances have been tested during the past six years.

"Lime, gas-lime, kainit, corrosive sublimate, sulphur, Bordeaux, cupram, oxalic acid, sulphate and sulphide of ammonia, bi-sulphide of carbon, sulphuric acid, kerosene, formalin, creolin, and benzine have each been added to the soil, and nearly *all have had no effect upon the scab. A few reduced the* disease somewhat, as corrosive sublimate, Bordeaux, and cupram, but not enough to render them of practical value. Lime increased the percentage of scab.

"Of the whole list, sulphur only has yielded results which warrant its being recommended to potato-growers as a preventive of scab. It is not uniformly active, depending, probably, upon the conditions of soil temperature and moisture.

"For practical use, 300 pounds applied to the open row are deemed sufficient. It is best to roll in sulphur the freshly-cut 'seed,' as it prevents rapid drying out of the water.

"The soaking of scabbed potatoes in corrosive sublimate has not proved of much practical value when they were planted under the conditions of the experiment, namely, in badly scab-infested soil.

"Uninfested soil may be readily contaminated by the introduction of scabbed potatoes or beets.

"The germs of potato scab, while not readily destroyed by boiling, seem to be largely destroyed by passing through the digestive tract of cattle.

"Special exposure (ridging) of scab-infested soil to the elements during the winter months does not appreciably affect the vitality of the disease.

"Susceptibility to scab is greater in some varieties of potatoes than in others.

"No plants, save the potato and beet (and probably the radish and turnip), have been found subject to root scab. All attempts to inoculate various species, both wild and cultivated, many of them closely related to the abovenamed hosts, have proved unsuccessful.

"Experiments have demonstrated that the scab fungus is actively retained in the soil for at least six years without the presence of potatoes or beets."

In Tasmania scab has often been noticed to be worse in land newly burnt over, where wood-ashes are plentiful; also in heavily manured land. Dr. Cobb says:—"It occurs in all sorts of land, but is more prevalent in sandy soils and in soils containing much lime, and is said to be more virulent in crops fertilised with manure containing much common lime or with wood-ashes."

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In speaking of the liability to disease of plants generally, Dr. Cobb also says:—"The relation of manure to disease may be briefly stated by saying that the promotion of a growth that is too soft and succulent is a direct invitation to parasites. Tissues of this sort are much more readily penetrated by the parasites, and when once the parasites have entered such tissues they find there the abundance of moisture that constitutes the best condition for their growth. The aim in manuring should be to promote a vigorous growth that is at the same time hardy and resistant to disease. So far as crop diseases are concerned, the most common mistake is overdosing with nitrogen."

Wet Rot, or Brown Rot of Potato.

This is a bacterial disease (*Bacillus solanacearum*) which has been noticed in several parts of Tasmania, and is fairly common in Australia. Unlike the other diseases noted here, it does not attack, practically, all the plants in the affected area, but takes one here and there. The first sign of it is a yellowing of the leaves and stems; the latter then become flabby and bend over, and soon after the whole plant dies.

The affected tubers when cut into are seen to have an irregular dark ring, consisting of numerous small brownish spots. In cutting the potatoes for seed any that are noticed to be affected in this way should be boiled up. In healthy potatoes, although a ring can often be seen, it is usually more or less purplish in colour and not spotted.

This disease appears to be more troublesome in warmer parts of the world than in Tasmania.

*Gall-worm.**

This pest is a microscopic worm (belonging to the genus *Tylenchus*), which causes small nodular swellings or galls to appear on potatoes; but the roots of nearly all plants are attacked, and it is certain that once it comes to a farm or orchard it has come to stay. And in no way could it be more easily introduced into fresh places than by affected potatoes. Roots of many plants attacked have numerous small swellings, much, in fact, as if small knots had been tied in them; in others they are thickened and distorted, much as the roots of the apple are by the woolly aphis.

Cereals are not attacked to any extent by these worms, owing to their hard fibrous roots not being favourable to the development of galls, but almost all soft roots are attacked. The worms when hatched from the eggs are minute, free-moving creatures, in appearance much like other worms, but too small to be seen by the naked eye: the females soon enter roots and commence to swell, so that when full-grown they are somewhat pear-shaped, and are little more than bags of eggs. As they grow they cause the roots to form galls. By careful manipulation of the affected roots they can now be obtained. To see them, take a root with the gall swellings on it, and place it in water, and tease it to pieces with needles: the worms in many instances will be broken, but they will often fall out entire, and then appear like minute whitish seeds.

* Gall-worm, although not a fungus, is noticed here on account of its importance to the potato.

This worm is known to be very destructive in America, Europe, Africa, and in parts of Australia, especially the coastal districts of New South Wales. In Tasmania so far it appears to be known only from certain parts of the north-west, but potatoes from there are frequently condemned in Sydney for it.

So far as the root-gall is concerned, there is no way by which the seed potatoes can be treated to destroy the worms without at the same time destroying the potatoes for seed purposes. Frost seems to have little or no effect on the worms, and long droughts, although they destroy the worms themselves, have little effect on the eggs. Loose wet soil is most favourable to the worms, as they can easily move about in it, and, with their eggs, they are easily transported in small streams of water, such as drains.

Dr. Cobb gives the following list of plants attacked:—

"*Badly affected.*—Roots of cabbage, kale, potato, banana, radish, okra, pea, peanut, cowpea, bean, squash, pumpkin, melon, cucumber, tomato, beet, plum, apricot, peach, almond, fig, English walnut, willow, gourd, bigonia, sunflower, amaranth, dahlia, koniga, iberis, achryanthes, purslane, sand-purslane, verbesina, worm-wood, Jerusalem oak.

"*Slightly affected.*—Roots of cotton, egg-plant, pepper, spinach, cassava, maize, orange, grape, mulberry, walnut, pecan, hibiscus, iceplant, parlor-ivy, morning-glory, nolana, petunia, spirea, Bousstingaltia, flowering almond, buddleia, Cape jessamine, shepherd's purse, blackberry, dewberry, eupatorium, cypress vine."

He also says:—"The extent of the damage done by gall-worms is difficult to estimate. Much land in Europe has been so badly infested that certain crops—for example, sugar-beet—had to be abandoned altogether. Not a beet-root would mature. The plants broke the ground, languished a few weeks, and then died. All that can be done in combating root-gall must be directed towards prevention. Once the gall-worm gains access to the roots, the game is up."

He says, in addition:—"I would caution agriculturists, seedsmen, and nurserymen against rearing, buying, or selling trees, plants, or tubers which show any swelling on the roots, except such as are well known to be natural to them. I know of cases where this worm was introduced in seed potatoes, and I am confident that this is one of the common ways that this pest travels *en masse* from one district to another. Closely scrutinise seed potatoes, and unhesitatingly refuse any that show galls."

I wrote to Dr. Cobb for his opinion as to the best time in which to investigate this pest in Tasmania. He replied as follows:—

"I think you will find it best to gather your statistics in summer, and pay special attention to potatoes, *as it is in these that this pest is most often distributed.* The reason is of course, that this crop is propagated by tubers. Any inspection directed against this pest should take cognisance of the movements of potatoes. The time will come when my numerous warnings, that have so far fallen on rather stony ground, will be heeded—too late, as usual. It is one of the worst of pests."

The Potato Blight, Murrain or Rot.

This (*Phytophthora infestans*) is the most serious disease that affects the potato, all parts of which are attacked by it. So far, it is not known from Tasmania, although it may arrive here any year, as it is widely distributed in New Zealand, and also occurs in Norfolk Island.

Tasmania and most of the Australian States at present prohibit potatoes from coming in from New Zealand, and this is a very wise precaution; but when it is considered that one spore would be quite sufficient to start the disease, and that during an outbreak countless millions of these spores are produced and carried about by the wind, it seems quite possible that the disease might be brought to Tasmania in this manner.

Dr. Cobb, in speaking of it, remarks:—"The fungus which causes this evil-smelling disease has more than once been the cause of national calamity. By annihilating the potato crop in Europe in certain years, it has created famines, in consequence of which many people have perished. It first made its appearance in Europe as a pest about 1845. There is reason to believe that it is a native of America, the original home of the potato. It attacks not only the potato, but also various species of the genus to which the potato belongs (*Solanum*), as well as the tomato, bitter-sweet, petunia, and other plants.

"The first symptom of the disease is the appearance of yellowish, afterwards brownish, blotches on the foliage, which, in moist weather, soon become black. These blotches are accompanied by an external glistening 'bloom' on the still fresh parts of the plant, a bloom caused by the fungus coming outside to fruit. An offensive odour arises; the foliage and the stems drop to the ground a mass of putrescence; the tubers also putrify. All these changes may, if the weather be moist, cloudy, and warm, take place in so short a time as 36 hours. The months in which these appearances would be likely to occur are January and February. Careful examination has shown that the disease is present here and there for some weeks previous to its virulent outbreak."

Once it appears in a country it has come to stay, although by spraying it can be greatly minimised in its intensity. But in favourable weather conditions and absence of proper treatment it goes like wildfire through potatoes. Most other diseases, although they may greatly reduce the yield, do not destroy the potatoes outright, but this one does, as it causes the tubers to putrify, so that the disease is often known as "stinking rot."

According to Musson, New Zealand, about the time of the outbreak of this disease, had about 30,000 acres under potatoes, but since the outbreak the acreage has been reduced by more than half. There is no certain information as to how the outbreak took place, although it is supposed to be from the importation of potatoes from Europe or America.

It has been stated that the disease cannot live where the mean temperature exceeds 77° Fah. for some time. It is also said to be worse on thin-skinned than on thick-skinned varieties.

The disease appears to be readily controlled by the use of Bordeaux mixture, although of course it cannot be stamped out by spraying with it.

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The potato is quite commonly attacked by a species of aphis, and this has often been the cause of alarm in Tasmania, owing to the common use of the word "blight" for any kind of aphis.

General Notes on Potatoes.

Like the apple, and in fact like any plant that is cultivated on an extensive scale in many parts of the world, the potato is attacked by a great variety of insects, and of fungus and bacterial diseases. Two pests, however, have caused more alarm than any others to the growers of potatoes; these are the potato murrain and the Colorado beetle. The latter (*Doryphora decemlineata*) will probably never come to Australia, but the former is almost certain to do so. It is by no means certain, however, that if it does it will ever be so serious a pest as it has been in Europe.

Professor Galloway, of the Washington Department of Agriculture, regards potato blight, macrosporium, and scab as the three most serious diseases of the potato in the United States.

As most of the pests here noted are liable to be introduced by seed potatoes, great care should be taken with the seed, and any that are suspected should be boiled and given to pigs or poultry. Cobb recommends that: "Where land has borne a diseased crop of potatoes, do not again immediately use it for potatoes. Give it a rest, or put in some other crop." It is also advisable to harrow up and burn the haulms of diseased plants, so as to destroy the resting spores of fungi and eggs, &c., of insects, and to turn in pigs to eat all small and overlooked tubers.

Sloping ground favours distribution of some kinds of pests by means of water in the soil.

Where diseased potatoes have been stored, it is quite possible that the diseases may be communicated to perfectly sound potatoes through the earth that adhered to them. It would therefore be advisable before putting healthy potatoes (and especially if intended to be used for seed) in the store-house, if this was thoroughly cleaned up and the floor sprinkled with a solution of bluestone or formalin to destroy any resting spores or germs. It is also not advisable to use sacks that have previously contained diseased potatoes.

Although from the outside many badly diseased potatoes appear to be perfectly sound, there are generally some readily recognisable signs present when the tubers are cut into. Care should be exercised at all times that only perfectly sound and healthy potatoes are set out as seed. Any that are suspected should be rejected, as many of the diseases which affect the potato are quite impossible to eradicate from the soil once they have become established in it.

And here it might be desirable to point out that although many growers prefer to use small and wasty potatoes as seed, potatoes that otherwise would be regarded as only fit for pigs; this is a very great mistake, and has been responsible for the running out of many varieties. Seed potatoes should be of fairly large size, sound, and of good shape, and should always be carefully selected. Experience with potatoes, as with most cultivated plants, has demonstrated the desirability of using only the best for seed. And it is a matter which can be easily

See "The Equitable"; do not delay.

proved by growing potatoes from sound, selected seed side by side with potatoes from small and wasty seed. Any man can, within certain bounds, greatly improve the quality of his potatoes by careful attention to the seed, and it is often from such attention that new and improved varieties are raised and perpetuated.

In several gardens in Tasmania where potatoes were examined, here and there a plant was seen to be dying; on further examination the stems of these above ground were seen to be waterlogged; below the surface the stems were usually hollow, and swarming with small ticks and springtails. Sometimes small maggots were seen at the connections between the stems and tubers; but the tubers themselves were not attacked. Probably overheating was the main cause of the death of these plants, as all of them were heavily manured with fresh stable-manure.

INSECTICIDE AND FUNGICIDE MIXTURES.

Following are given recipes for some of the most commonly used insecticide and fungicide mixtures, with notes on their preparation and use:—

Paris Green.

Paris green, 1 lb.
Lime, 3 lbs.
Water, 200 gallons.

Paris green is the material most commonly used against codlin grubs, and, being of a vivid green, it is much less liable to cause accidental poisoning than white poisons. When pure it contains about 44 per cent. of arsenic, but it is a material which is frequently largely adulterated.

Paris green is heavier than water; consequently, it needs to be constantly stirred to be kept in proper suspension. With the majority of spray pumps the agitator is not sufficient for this, so that a useful thing to do when using this poison is, at the end of every row, to turn the nozzle of the pump into the barrel, and pump the mixture back into itself.

It is also always advisable to add a small quantity of lime to the water, to neutralise any free arsenious acid which may be present in the Paris green, and which, in consequence, would be much more likely to injure the foliage it is sprayed upon. Some trees can stand a much greater amount of poison than others; the pear, for instance, is a much hardier fruit (in this respect) than the apple, and the apple than the peach. Some apples also (especially the Scarlet) are tenderer than others.

Paris green should not be simply placed in water, as much of it will float and form into small balls: it should be first placed in a bottle with water, and well shaken, when it can be easily poured out, and will not float.

Measuring small quantities of poison is usually a rather troublesome affair, and with Paris green it requires to be done carefully, in order to avoid putting it on too strong. The majority of knapsack and hand pumps are worked with about 2 gallons of water; for this quantity one-sixth of an ounce of Paris green is needed (at the rate of 1 lb. to 192 gallons of

water). To readily measure this out a useful plan is to have a pickle-bottle (or other flat-bottomed bottle) marked off into six equal parts by gummed paper or diamond scratches; if in the bottle 1 ounce of the poison is placed, and it is then filled with water, it will be seen that on thoroughly shaking the bottle and pouring out the fluid to the top of each mark in succession, exactly one-sixth of an ounce can be readily measured out. It is by attention to small details such as these that injury to the trees is prevented, for in nearly every instance where trees have been injured by any spraying material it has been found on investigation to be due to careless or improper use of the materials recommended.

On looking down into the barrel or bucket containing Paris green the water often looks a distinct green and the poison is apparently well distributed: and this has often caused those spraying to think there was no need for violent and continuous agitation. But a strong proof for the necessity of continuous agitation can be obtained by placing some Paris green in a bottle with water. On violently shaking the bottle the poison will be evenly distributed; but on placing the bottle at rest the poison will be seen sinking rapidly to the bottom. In a few minutes most of it will be there, but the water will still appear green when viewed from the side, and when viewed from above it will appear of an even deeper green.

The New South Wales Department of Agriculture has published the following simple test for Paris green:-

"Paris green contains copper and arsenic, and is an arsenite of copper. It does not dissolve in water, but, when pure, dissolves readily in any common acid, or in ammonia, with the latter forming the dark blue colour characteristic of salts of copper. When either acids or ammonia are used, any sulphate of baryta* present can be at once detected, as it will remain undissolved in the form of a heavy white powder."

Arsenic and Soda.

White arsenic, 1 lb.
Washing soda, 4 lbs.

Boil in 1 gallon of water for 15 minutes or till thoroughly dissolved. If properly prepared the mixture should look like dirty water, and there should be no sediment.

Shortly before using, slack lime in water at the rate of 1 lb. to every 10 gallons, and then add 1 pint of the prepared arsenic and soda to every 40 gallons, being at the rate of 1 lb. of arsenic to 320 gallons of water. This is Kedzie's mixture.

Arsenic and soda is certainly a very useful spray (in South Australia better results were obtained with it in the official trials than from any other substance). Its effects against the codlin grubs are equal, if not superior to Paris green. For large orchards it is probably the best material to use; once properly mixed in the spray pump no stirring is necessary. On account of its colourless appearance, however, it is an exceedingly dangerous poison to have about the house, so that only enough should be made for immediate requirements.

* One of the substances commonly used for adulteration of Paris green.

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London Purple.

London purple, 1 lb.
Water, 200 gallons.

London purple is a useful spray for certain purposes, but its composition is so exceedingly variable that it is seldom used, although cheaper than Paris green. It appears also much more liable to injure tender foliage. Being heavier than water, it needs to be constantly stirred when in use. A small quantity of lime should be added to the water to neutralise any free arsenious acid that may be in the poison.

Arsenic and Lime.

White arsenic, 1 lb.
Lime, 3 lbs.*

Boil in 2 gallons of water for 40 minutes, and use at the rate of 1 lb. of arsenic to 400 gallons of water, or 1 pint of the liquid to 25 gallons of water.

Arseniate of Lead.

Arseniate of lead, 1 lb.
Water, 200 gallons. 25. best of all for Codling

Can be used without lime being added. ~~This mixture may be said to be still in the experimental stage, so far at least as Tasmania is concerned.~~

Bran, Arsenic, and Sugar Mash.

Mr. Coquillet, referring to experiments made in California against grasshoppers or locusts, says:—

"A remedy that has been very successful in destroying locusts consists of a certain proportion of bran, arsenic, sugar, and water. These have been used in different proportions, but the one that appears to give the best results consists of one part by weight of arsenic, one of sugar, and six of bran, to which is added a sufficient quantity of water to make a wet mash.

"This preparation is usually prepared in wash tubs or half-barrels. One of these is filled about three-fourths full of dry bran, and to this is added about 5 lbs. of arsenic, which is thoroughly stirred through the bran with a spade or shovel. Five pounds of sugar is next thrown into a pail, which is then filled with water and the sugar stirred until it is dissolved, when the sugar-water is added to the bran and arsenic and the three well stirred, more water is added, and the stirring continued until every portion of the mash becomes thoroughly saturated.

"About a teaspoonful of this mash is placed at the root of each tree, shrub, or plant infested with locusts, dropping it in the shade when this can be done.

"I have known locusts to be killed by eating some of this mash that had been put out over a week previously. The poison works very slowly, and when put out early in the

* With good lime; probably in some parts of Tasmania at least 4 lbs. would be required.

morning will show but little effect upon the locusts until quite late in the day.

"This mash was used upon about 300 acres of orchard and vineyard on the Bubach Plantation, and about two weeks later scarcely a living locust was to be seen, where they could have been counted by the hundred, or even thousand, before the poison had been applied, the ground in many cases being literally covered with the dead bodies of the slain.

"Of course, this mixture should not be put out in places where poultry or any of the domestic animals can get at it."

At Kempton a farmer placed some of this mash amongst some mangolds, with the result that large numbers of grasshoppers were killed. On one square yard 245 dead grasshoppers were counted, on another square yard 161. It has also been found to be very attractive to earwigs, snails, and slugs. In Western Australia a similar mash is largely used to protect grape vines from the attacks of a very destructive cut-worm. Treacle can be used in place of the sugar if desired.

Oils.

Various oils are used against scale insects and aphides all over the world. They are either used pure (as a wash, or in the form of a very fine mist by the aid of a machine known as an atomiser) or emulsified with soap and water, or with milk, or mechanically mixed with water. The effect of the oils is to choke up the spiracles (or breathing holes) of the insects they come in contact with, and so suffocate them; consequently they must be brought in actual contact with the insects' bodies to be of use, and as a rule the finer they are applied the better chance there is of their actually coming in contact with all of the scale insects or aphides on the trees sprayed upon. But as many scale insects and their eggs are protected against ordinary fine sprays by their coverings, it often needs to be put on in a rather coarse form, so as to allow the surplus to penetrate beneath the scales. On a large tree also it is difficult to cover all parts with a very fine spray. The soaps used are also of use as insecticides, but the water is simply to reduce the cost of applying the oils, or to neutralise their destructive action on the trees when used pure.

So far as oils are concerned, it can be told within a few hours or the next day whether the spray is going to be effective against the mussel scale or not. If it is to be, it will be noticed that, on scraping off the scales into the hand, a sprinkling of eggs does not take place, and on examination with a magnifying-glass oil can be seen glistening amongst the eggs, and this glistening appearance remains till the eggs die (which, however, may not take place for some months). On unsprayed trees (or on parts of trees not reached by the spray), on scraping off the scales into the hand, eggs will be seen sprinkled all over the hand, and a few of these will remain even after the scales have been gently blown away. On looking at the eggs under the scales with a magnifying-glass, also, it will be noticed that they have a mealy or floury appearance, and without a trace of the glistening appearance caused by the oils. We have therefore a ready test for the efficacy of oil sprays.

With oils painted on the trees full strength (as is sometimes done), it is possible that the oil may spread an inch or two under favourable conditions; but the oils put on in an emulsion do not travel any distance, and the idea that the oil

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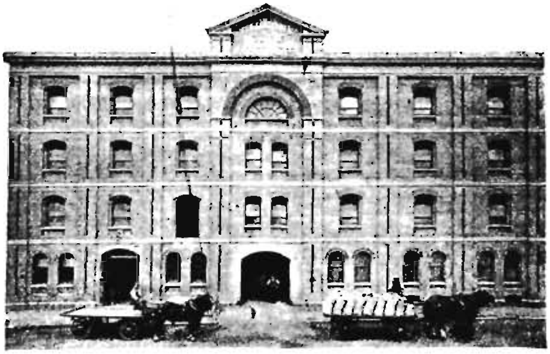

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will extend to a considerable distance from the parts sprayed is quite erroneous.

So far as the actual spraying with any mixture is concerned, the men doing the work should be instructed to see that the fruit-spurs and tops of the trees are well covered with spray—too often they are satisfied to spray the bark of the branches alone. Naturally, it takes a considerably larger amount of material to cover the spurs and tops, but as these are often just as badly covered with scales, and the fruit-spurs are nearer to the apples themselves than the bark of the branches, and as each scale contains on an average 70 eggs, it follows that every scale missed on the spurs and tops, and of which the eggs hatch, means 70 young insects in early summer.

Speaking generally, to effectively spray apple trees in bearing in the winter, from 1 to 2 gallons per tree must be used, according to size--for very large trees even more must be used; and if the spray used is a summer one, considerably more must be used, as a great deal of the material will be wasted on the leaves.

For the mussel scale, undoubtedly a winter spray is best, as the spray materials used can be put on at considerably greater strengths without injuring the trees; moreover, a much smaller quantity is necessary, as there are no leaves to interfere with the spray, and owing to pruning being over, there is a minimum of bark to be covered.

A winter spray in Tasmania, either for the mussel scale or black spot, must be of such a nature that it is not easily washed off by rain.

The sulphur, lime, and salt mixture is regarded as the best for scale insects in California and some other parts of the world, but in Tasmania so much rain falls as a rule about the time that it is put on, that its benefits are greatly reduced. The oil sprays, on the contrary, are very little affected by rain, and when made and put on properly leave little to be desired. But crude petroleum and red oil should be used only in winter, before the leaf-buds burst open; if left too late they are liable to injure the trees, and as a matter of fact many trees have been injured at the Huon through spraying trees with red oil in September. In a number of cases the emulsion appears to have been improperly made, and this no doubt would account for some of the injury; but the main cause of damage was the late application.

If apple buds are examined in winter they will be seen to be about the same thickness as their supporting spurs; each appears to be somewhat top-shaped, and composed of a number of closely overlapping scales, so tight that nothing can penetrate between them. Later on the buds begin to swell and lengthen, and the scales become loose. If then any spraying is done at this time some of the oil is bound to get between these scales and the buds themselves, with the result that many of these will be destroyed, although on the whole not much damage may result. Later, as the swelling proceeds, the scales drop off, and the young leaves can be seen quite distinctly. Any spraying done with an oil emulsion at this time is certain to result in injury, as the young leaves are then most susceptible to damage, and the spray is retained by the buds, much as it would be by the same number of small sponges. No spraying, therefore, with the red or crude oils should be done after August in Tasmania.

Various oil emulsions have been used for spraying trees in summer when the young scales are on the move; but although

the kerosene emulsion can then be used with care, it is very risky to use the heavier oils. In fact, the only occasion when, to my knowledge, the crude petroleum was used in summer in Tasmania the result was that fully half of the crop was destroyed, although the trees themselves were not injured.

The oils when prepared are very readily applied, as their nature keeps all parts of the pump in good order, and there is no clogging of the nozzle with them, such as frequently occurs with mixtures containing lime; they can be used with the finest nozzles, and do not wear these out at anything like the rate that mixtures containing lime do.

Oils as Washes.

The oils are sometimes used with a brush in winter against trees densely covered with scale insects, but the cost of so applying them to large trees is prohibitive. They should be painted very lightly on the trees in the middle of winter, before the buds begin to swell, otherwise the trees may be seriously injured. Red oil is more expensive than kerosene, and kerosene is equally as effective, and probably much safer, to use on trees. In using oils for such purposes, however, it must always be borne in mind that the trees must be thoroughly dormant; if used when the buds are swelling serious injury is almost certain to result. Moreover, in painting the trees, the oil should be put on as lightly as possible: to heavily coat the trees with oil would destroy many of the terminal shoots, no matter at what time of the year the oil was applied, and as much of the oil would run down the limbs it would be wasted, besides possibly seriously injuring the roots. The oil is certainly a complete cure for the mussel scale; it destroys as well all the hibernating eggs of the red and other mites, and quite possibly many codlin grubs. Trees which have been so treated very often for years afterwards have a healthier and more vigorous appearance than untreated trees, even when they at first sight appear to have been seriously injured. In the trees about Glenorchy, pruned so that any part of the tree can be reached without a ladder, the cost for treatment with the red oil averages about 5d. per tree (it would, of course, be less if kerosene were used); for the larger trees, such as are grown about the Huon and elsewhere, the expense would be greater. The application of pure kerosene to trees has, in many instances, had very serious results, not infrequently the trees themselves, especially peach trees, being killed. Used in a proper method on apple trees, however, it appears to be quite safe, and there is certainly no more efficacious remedy.

Oil Emulsions.

The making of an emulsion is easy, provided that four details are kept in mind:

1. The water must not be brackish.
2. It should be boiling when the emulsion is prepared.
3. A strong mixture should be prepared first.
4. Thorough churning.

If any of these points are neglected, failure is almost certain to result. The emulsions, whatever oil is used, can be made in much the same way, as follows:—

1 gallon of water; 1 pound soap. Boil together till the soap is dissolved, then add 1 gallon oil, and churn thoroughly. After churning, add from 8 to 14 gallons

water. If the day is very cold this water should be warmed, otherwise the whole is apt to turn into jelly.

Larger quantities can be made in same proportions.

Red Oil Emulsion.

This is perhaps the most favoured remedy at the Huon for mussel scale, and it is certainly a very effective one when properly made and applied. It is, however, equally as dangerous as the crude petroleum when used late in the season, is no more effective, and is considerably dearer. The common strength it is used at to form an emulsion is 1 gallon red oil, 1 lb. soap, and 15 gallons water.

In adding the oil to the soapy water, care must be taken that the water is boiling, and that for every gallon of water used a gallon of oil must be added. Then comes the churning, and if this is done properly the emulsion will last for weeks, and can be diluted with any desired quantity of water. It is not enough to stir the emulsion about with a piece of board, but it should be thoroughly churned. This can be readily done with a garden syringe, a Billen's pump, or even an old churn, but if the emulsion is not properly made in the first instance the oil is always liable to float to the top and injure the trees. If a large amount of oil floats to the top of the spray-pump this is proof positive that the emulsion has not been properly made. It has sometimes been stated that if the oil and soapy water are boiled together an emulsion can be readily prepared, but this is not the case.

When newly churned together, a gallon of oil and a gallon of water will take up the space occupied by nearly three gallons, so when made in a comparatively small receptacle this fact has to be remembered, otherwise the emulsion is apt to overflow. When first made it looks something like cream. The strong emulsion should first be placed in the spray-pump, and then the required amount of water added. This is the critical stage to detect badly-made emulsions, as with such the oil soon floats to the top, whilst with a well-prepared one the emulsion and the water mix without any trouble.

Practically any soap will do to make an emulsion with, but common bar soap is better than soft soap, and is also cheaper. Less than one pound to the gallon is actually required, but the larger the quantity of soap used, the less risk there is of making a mistake, and soaps by themselves are useful insecticides.

Without adding other substances, it is quite impossible to make a good emulsion if the water used is at all brackish, as the salt destroys the emulsifying action of the soap, and when such water is used the oil soon floats to the top. Bluestone also acts on the soap in much the same way, so that it is important to thoroughly clean the pump out if it has previously been used for Bordeaux mixture.

Mineral oils are very liable to cause rubber to perish, so after use all hoses should be carefully washed out with clean water.

Kerosene Emulsion.

Kerosene emulsion is largely used against scale insects and aphides, and at varying strengths. In winter it is often used in the proportion of one part kerosene to one of water. The ordinary summer strength is 1 gallon kerosene to 15 of water, with 1 lb. of soap, and at this strength, if properly made, it can be sprayed on trees (except on hot days) without

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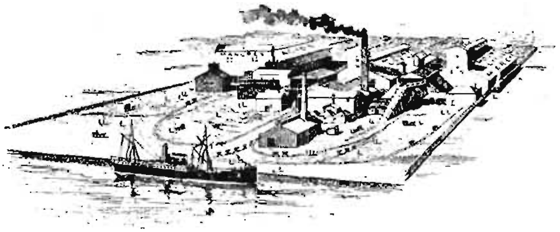

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danger. It is a good remedy against mussel scale when on the move in early summer, when it would be dangerous to use the heavier oils in almost any effective strength.

Crude Petroleum Emulsion.

In departmental experiments against the mussel scale in 1905 it was demonstrated that crude petroleum was better than any other material then used (and including red oil, sulphur, lime, and salt, and several patented sprays), besides being far cheaper. It costs about 7d. a gallon by the barrel when landed in Hobart, as against from 1s. 2d. to 2s. for red oil, and about 10d. for kerosene.

This is a dangerous spray at almost any strength in summer, but is quite safe in winter, when the trees are thoroughly dormant; and with it it is quite possible to exterminate the mussel scale from an orchard in one season. The strength recommended for a badly infested orchard is 1 gallon crude petroleum, 1 lb. soap, and 11 gallons water.*

Resin Wash.

"Twenty pounds resin, 5 lbs. caustic soda (70 per cent.), 2½ pints fish oil; water to make 100 gallons.

"Ordinary commercial resin is used, and the soda that is put up for soap establishments in large 200-lb. drums. Smaller quantities may be obtained at soap factories, or the granulated caustic soda (93 per cent.) used, 3¼ lbs. of the latter being the equivalent of 5 lbs. of the former. Place these substances with the oil in a kettle, with water to cover them to a depth of 3 inches or 4 inches. Boil for one or two hours, occasionally adding water, until the compound resembles very strong black coffee. Dilute to one-third the final bulk with hot water, or with cold water added slowly over the fire, making a stock mixture, to be diluted to the full amount as used. When sprayed the mixture should be perfectly fluid without sediment, and should any appear in the stock mixture reheating should be resorted to. For a winter wash dilute one-third or one-half less." (Washington Department of Agriculture.)

This is a mixture which is greatly in favour in America, especially against aphides and scale insects when on the move.

Soap and Tobacco.

A useful mixture against all sorts of aphides is soap and tobacco. Boil soft soap or any other cheap soap with leaf or sheep dip tobacco (1 lb. of each to 20 gallons of water), and spray on the trees or garden plants whilst hot. It will only be slightly warm by the time it reaches the trees, &c., but every degree of warmth adds to its penetrating power, and every aphis touched by it will be killed. In New South Wales the following is recommended:—

Tobacco Wash.

Tobacco	2 lbs.
Soft soap	1 lb.
Water	6 gall.

Steep the tobacco in a bucket with about 2 gallons water, and let it stand over night. Strain in the morning, adding the

---

* Crude petroleum, however, seems to be very variable in its composition, and some is so much mixed with resin that it is difficult to get it to emulsify.

soft soap and the rest of the water warm. The nicotine of the tobacco kills the aphis, the soap assisting to make it penetrate and stick. This wash will not injure the most delicate foliage upon young peaches.

Bordeaux Mixture.

The remedy most in favour against fungus pests all over the world is the Bordeaux mixture (so called from having been first used at Bordeaux, in France). It first came into notice in 1882, since when it has come into almost universal use. The strength commonly recommended is—

Water, 50 gallons.
Copper sulphate (bluestone), 6 lbs.
Unslacked lime, 4 lbs.

This mixture can be used in Tasmania with perfect safety on apple trees in the winter; but on many trees (especially Scarlets) it has a burning effect when used later in the season. Probably as good a proportion as can be used on apple and pear trees just before they are bursting into bloom is as follows:—

Bluestone, 1 lb.
Unslacked lime, 1½ lb. (or less if good lime is used).
Water, 10 gallons.

In Tasmania experience has shown that the *time* in which spraying is done for the black spot is of equal importance with the material used. The Departmental experiments, as well as many others carried out at the Huon, proved that the best time to spray is just before the blossoms burst; spraying can actually be done whilst the trees are in full bloom without any injury resulting; but on account of the liability to poison bees it is advisable not to spray whilst the trees are actually in bloom. A second spray is also useful when the fruit is the size of small marbles, but this spray requires to be weaker. Spraying the trees in the middle of winter seems to be of very little use in Tasmania, although elsewhere it has been reported to be of considerable use.

It has been found advisable to recommend an increase in the quantity of lime to that used elsewhere, as the majority of that obtainable in Tasmania is very inferior for spraying purposes (being full of small stones and grit, so that it does not slack into a grainless paste, as perfect lime will do). The mixture recommended, therefore, is 1 lb. of bluestone and 1½ lb. of lime to every 10 gallons of water. Even this is sometimes found to be too strong to spray on Scarlets and some other apples just after they have set, so that a weaker mixture is needed, as follows:—

Bluestone, 1 lb.
Unslacked lime, 1½ lb.
Water, 20 gallons.

"It has been found that the method of combining the ingredients has an important bearing on both the chemical composition and physical structure of the mixture. For example, if the copper sulphate is dissolved in a small quantity of water, and the lime-milk diluted to a limited extent only, there results, when these materials are brought together, a thick mixture, having strikingly different characters from one made by pouring together weak solutions of lime and copper sulphate. Where the mixture has been properly made there

is scarcely any settling after an hour, while the improperly made mixture has settled more than a half."—(Galloway.)

The best method to prepare 40 gallons of the Bordeaux mixture, according to Professor Galloway, is to dissolve the quantity of bluestone used in 20 gallons of water, slack the lime, and add it also to 20 gallons of water, then slowly mix these in the spray-pump as required. The bluestone can be dissolved by placing it in a coarse piece of sacking and suspending this just below the surface of the water, but it takes some hours to dissolve in this way; it can, however, be rapidly dissolved in boiling or very hot water, and is equally effective when so prepared.

"It is probable that the use of air-slacked lime not only causes injury from leaving a small amount of copper sulphate in solution, but from the formation of the basic sulphate of copper, which in itself is injurious. In the use of Bordeaux mixture prepared with freshly-slacked lime it is conceivable that injury may occasionally result if the two solutions are not thoroughly mixed and the solutions of copper sulphate and lime are too concentrated."—(Fairchild.)

If too much bluestone is in the mixture it will scorch the leaves and young fruit. A simple test is to place a shining *nail or the blade of a knife in the mixture, when, if too much* bluestone is present, in about one minute the nail or knife will become discoloured, whilst if there is a sufficiency of lime no alteration will take place. A common custom in Tasmania is to put just as much lime into the mixture as it will hold, with the result that the nozzles are being continually choked, and no real advantage is gained, whilst as a matter of fact lime by itself, though to a less extent than bluestone by itself, is liable to scar the young fruit. In reporting on some Victorian experiments against black spot, Mr. McAlpine (the Government Vegetable Pathologist) stated that 6 lbs. of bluestone and 4 lbs. of lime in 50 gallons of water caused no injury to the young buds; but that 6 pounds of bluestone and 12 lbs. of lime to the 50 gallons "was quite as severe as a plain solution of bluestone."

Bluestone rapidly eats into any iron with which it comes into contact, so that it should be dissolved in wooden vessels before it is mixed with the lime. Sulphate of copper, or bluestone, should, as its name implies, be blue: this is mentioned as it is often largely adulterated with greenstone or sulphate of iron—an inferior and cheaper chemical. If much of the material bought is noticed to be green, this is a certain sign of adulteration.

There are few fungus diseases that are not subject to more or less complete control by the Bordeaux mixture.

Burgundy Mixture.

A mixture which will probably replace Bordeaux mixture to a great extent is the Burgundy mixture. This is prepared by substituting common washing-soda for the lime. The quantities recommended are:—

Bluestone, 1 lb.
to Washing-soda, 2¼ lbs. According to quality.
Water, 10 to 15 gallons.

The benefits by using this mixture are that there is no trouble in obtaining fresh soda, and that as the soda com-

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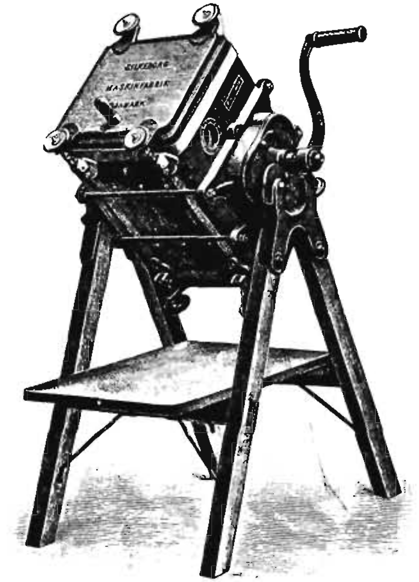

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pletely dissolves there is no gritty sediment that tends continually to choke the nozzles. It can be prepared and applied exactly the same as the Bordeaux mixture.

Test Paper for Bordeaux and Burgundy Mixtures.

In both the Bordeaux and Burgundy mixtures the most useful fungicidal element is the bluestone; the lime or soda is added almost solely to neutralise the caustic action of the bluestone when used alone, consequently just as much should be added as will do this, and no more. A rough test for this is the nail or pen-knife already mentioned; but a quicker and more certain test is one made by dissolving phenolptaleine in alcohol, saturating ordinary blotting-paper with this, and drying it. On dipping the prepared paper into the mixture, if there is a sufficiency of lime or soda the paper will instantly turn pink. A very slight pink colour shows that there is just enough lime or soda, whilst a very deep colour shows that there is too much.

Samples of this prepared paper may be obtained on application to the Council of Agriculture.

Eau Celeste.

"The preparation of eau celeste is very simple. To each 2 lbs. of copper sulphate dissolved in 6 or 8 gallons of water add 3 pints of strong ammonia, stir thoroughly, and dilute to 45 gallons. Four pounds of copper to 3 pints of ammonia for 45 gallons of water has also proved an effective winter spray.

"For dormant trees this spray is safe, but for the treatment of foliage it is too corrosive and burning. It is also quite corroding to nozzles and other metallic portions of the spraying outfit."—(Pierce.)

Modified Eau Celeste.

"The modified eau celeste is less injurious to foliage than the eau celeste, but is more liable to injure tender leaves and buds than the well-made Bordeaux mixture. Its preparation is nearly as simple as that of the eau celeste. To 4 lbs. of copper sulphate dissolved in 10 or 12 gallons of water add 3 pints of liquid ammonia, dilute with water to 45 gallons, and stir in this mixture 5 lbs. of sal soda (common washing-soda) until dissolved. In preparing this spray of different strengths the same proportions of the chemicals may be maintained."—(Pierce.)

Ammoniacal Copper Carbonate.

"The ammoniacal copper carbonate is one of great usefulness in the treatment of fruit for fungous diseases, especially where the spotting of fruits by the use of lime is to be avoided. The fungicidal action of this spray is, however, far inferior to the ordinary Bordeaux mixture.

"The manner of preparing this spray is simple. Place 5 ozs. of copper carbonate in the bottom of a 3-gallon crock; from a 2-gallon vessel full of water pour about ½-pint of water upon the copper carbonate, and stir the latter until it becomes like paste; now add the remainder of the 2 gallons of water, stir again, and then pour into the mixture 3 pints of 26° ammonia. After this has been thoroughly stirred, it should be covered and allowed to stand for half an hour, when the whole should be added to a barrel containing 43 gallons of water; when well mixed this spray is ready to be applied."

To prepare copper carbonate:—In a barrel dissolve 6 lbs. of copper sulphate in 4 gallons of hot water; in another wooden vessel dissolve 7 lbs. of washing or sal soda in 2 gallons of hot water. The soda should be clear (translucent), and not white and powdery, as it appears when air-slaked. When cool pour the soda solution slowly into the copper solution. As soon as bubbles cease to rise fill the barrel with water, stir thoroughly, and allow the mixture to stand over night to settle. The next day syphon off the clear liquid from the top with a piece of hose, fill the barrel with water, stir thoroughly, and allow it to stand a second night. Syphon off the clear liquid the second day, fill the barrel with water, stir, and syphon off the clear liquid once more the third day. Now pour the wet sediment from the barrel into a crock or other earthen dish, strain out the excess of water through a cloth, and dry slowly in an open oven, stirring occasionally, if necessary, to prevent overheating. Prepared in this manner there should be obtained, if none of the sediment in the barrel be lost, about 2·65 lbs. of carbonate of copper."—(Pierce.)

Sulphur, Lime, and Salt.

"Forty pounds of lime (unslacked), 20 lbs. sulphur, 15 lbs. coarse salt.

"Add 40 gallons of water to the above materials, stirring thoroughly while the lime is slacking. Boil fully three hours, then add enough water to make 80 gallons of the solution, then strain and apply milk-warm. Use only on deciduous trees, and when said trees are dormant."—(Muscott.)

Sulphur, lime, and salt is the principal mixture used against scale insects in California. It is the substance officially recommended in Victoria, and against ordinary scale insects has been very beneficial in Tasmania.

It should be noted that in Tasmania the lime (at least that in general use) is very inferior for spraying purposes, so that instead of slacking into a fine, pasty material, a very considerable amount of gritty sediment is left, and which interferes with the spraying. This appears to necessitate the use of about 5 lbs. of the Tasmanian lime to 4 lbs. that is used elsewhere. Shell lime appears to be of inferior strength to stone lime, consequently still more of it, in proportion, requires to be used; it, however, goes into a much finer powder, so that it is much less liable to choke the pump-nozzles. In connection with this choking, it is to be remembered that the nozzles are much less liable to be choked with a strong than with a weak pressure.

Sulphur, lime, and salt is also useful in destroying such parasitic growths as lichens and fungi, which, in damp situations, do considerable damage to trees.

As an all-round winter spray there is probably no better mixture than this, but in Tasmania it is certainly not so effective against the mussel scale as some of the oils; probably because our winter rains considerably interfere with its action. It is largely used against black spot, but against this pest it is certainly less effective than the Bordeaux mixture. To properly prepare sulphur, lime, and salt takes a long while, and in use it is very severe on the face and hands; it is also liable to destroy clothing.

Tinned Lime.

In districts where it is difficult to get good lime, or to keep it fresh, it will often be found advantageous to buy the lime put up in tins for spraying purposes; thes are superior kinds of lime, and will always keep fresh until the tins are opened.

Hellebore.

Hellebore, 1 oz.
Water, 1 gallon.

The hellebore should be placed in boiling water for some time before being put in the spray-pump. It should be used perfectly fresh, as it is liable to deteriorate with age or exposure. Sometimes half an ounce or three-quarters of an ounce to the gallon may be found to be sufficient, but it is safer to use a full ounce to the gallon.

Bluestone for Smut.

"Immerse the grain 12 hours in a solution made by dissolving 1 lb. of bluestone in 24 gallons of water, after which place it for five minutes in limewater made by slacking 1 lb. of good lime and then diluting it to 10 gallons with water. This treatment is cheap, simple, and very effective. Grain thus treated, however, does not grow quite as well as that treated with hot water, but the difference in growth is inconsiderable."—(Swingle.)

Formalin for Smut.

"If 50 bushels of seed oats are to be treated, secure from a drug-store 1 lb. or a pint of formaldehyde (sometimes called formalin). Put into a barrel or cask 50 gallons of water, and pour in the 1 lb. of formaldehyde liquor to make the proper solution. Dip out about one-half of the solution into another cask, in order to treat two sacks of oats at the same time, thus facilitating the work. Place about 2 bushels of oats in each of two gunny sacks or large bags, and submerge the oats in the solution for 20 minutes; then lift the sacks from the casks, and let drain for a minute or two, so as to save solution. Empty the oats on a threshing-floor, or on a canvas, to dry.

The solution as used is not poisonous, and will not injure the sacks or clothing coming in contact with it.

It is well to treat the seed oats two or three days before sowing, to give ample time to dry. If the oats are shovelled over a few times it will facilitate the drying very much, and no difficulty will be experienced sowing with seeder or drill. The treated oats can be sown with a force-feed drill or seeder when quite damp, but the machine should be set so that it will indicate sowing about a peck more than the quantity desired per acre, as the oats are swollen, and will not run quite as freely as dry oats.

The treatment of seed oats seems to facilitate the sprouting; a difference of from two to four days in favour of the oats treated will be noticeable."—(R. A. Moore.)

Patent Mixtures.

There are many patent mixtures prepared for the destruction of insect and fungus pests, and doubtless many of these could be more extensively used if they could be supplied at reasonable prices: but any spray mixture to come into general use must be, as has been stated over and over again, cheap, simple, and

efficacious: cheap, to ensure that it will pay to apply it; simple, to avoid mistakes being made and the trees injured; and efficacious to justify its use at all. Speaking broadly, any remedy which costs on an average 6d. per tree is practically condemned before trial.

Notes on Spraying.

With the introduction and spread of noxious insects and diseases, it has become more and more necessary to combat many of these by spraying, as this is the only plan found possible to destroy many pests at a reasonable cost. Fumigation with hydro-cyanic acid gas is largely used for certain scale insects, and for certain of these is even better than spraying; but against many other insects, and especially against many fungus diseases, the only satisfactory treatment is spraying. By means of a spray trees, shrubs, vegetables, &c., can be rapidly covered with minute drops of liquid, which on drying leave behind particles of insecticides or fungicides.

If a man took a bucket of a prepared spray and threw it over a tree, the chances are that he would wet some of the bark and a few leaves, but the bulk of the material would be wasted; but if he sprayed the same amount, he would probably be able to wet every part of the tree above ground, and probably another tree or several other trees as well.

For some pests a spray should be applied in as fine a mist as possible; whilst for others a fairly coarse form should be used; and for others again what is wanted is a wash.

The greater the pressure used the finer the spray will be, and the more it will extend from the nozzle. Also, a pump using lime or other gritty materials is much less liable to choke than when the pressure is weak. The tree also can be covered in a much shorter space of time. Power pumps will almost certainly therefore replace hand-labour ones in the larger orchards.

It is important to do the spraying thoroughly, even if it is to apparently waste a considerable quantity of liquid; at the same time it must not be forgotten that the results obtained will depend less on the quantity used than on the completeness with which the parts are covered for which protection is sought. One good thorough spray is much better than two or three not done so well, and its effects will last for a greater period of time. Also, it must be taken into consideration what the spraying is done for; if for the mussel scale, the bark, and especially the fruit-spurs, should be well covered; if for the codlin moth, the young fruit should be covered; whilst for the black spot a general coating should be aimed for. It is also necessary with many sprays to see that the liquid in the barrel is kept constantly agitated, for some of the materials used will soon float to the top, whilst others sink to the bottom. The results often are that some trees are severely injured, whilst some are covered with a worthless spray. Too often when spraying the object of the man with the hose is simply to wet the bark. The orchardist should remember that spraying is usually very disagreeable work, and the men employed at it will often scamp it if they get the chance. The cost of many of the substances used is comparatively small, the principal expense being the labour; so that one spraying well done, even if a fairly large amount of the material is apparently wasted, will usually cost less than two or three hurried sprayings, and will also be much more effective.

When it is possible to spray for the same pest in the summer or winter, a winter spray is much to be preferred, as the trees being bare of leaves a much smaller quantity of material need be used, and the bark and limbs can be completely covered, as there are then no leaves to interfere with the spray. Also, it is possible to safely use remedies in the winter that later on would kill, or at least seriously injure, the trees.

In flower and vegetable gardens it will sometimes be found advisable when spraying has to be done to do this at night time. As a matter of fact, it would be usually impossible to touch earwigs, slugs, and snails with any mixture used as a spray during the day time, but by spraying at night time with contact sprays many of these can be easily destroyed.

It should be borne in mind, however, that although for most diseases and insects cheap and satisfactory remedies are known, and can be easily applied, there are several for which no satisfactory remedy so far has been discovered.

Pumps.

It is out of place in a work of this kind to recommend any kind of pump, but in selecting a pump care should be given to several details.

The Nozzle.—This should be of such a nature as to allow of a fairly large amount of material coming out in the form of a very fine spray, and the nozzle itself should be so made as not to be readily choked, or, at any rate, that it can be easily cleared when choked. With two hoses going at the same time the stoppage of one nozzle means practically that the work of three men and a horse is delayed till the nozzle is cleared. Large nozzles with two, three, five, and even more openings are common, but it is very doubtful if they are better than some of the single nozzles. It will usually be found that a nozzle discharging to one side is better than one discharging to the front; for very high trees a direct discharge nozzle is best, but for the bulk of Tasmanian trees the side discharge nozzle is much to be preferred.

The Hose.—The hose used should be as strong as possible, as owing to the nature of the work done it is especially liable to injury by twisting at the pump and near the spray-rod, and by kinking. A hose used for spraying gets very much rougher treatment than one used in an ordinary garden.

Extension Rod.—It is often desirable to have an extension rod, to enable the spray to be placed closer to the tree, and to direct it more quickly in a desired direction. A rod for this purpose should be from 6 to 8 feet in length, and preferably of bamboo. It will be found very useful for tall trees.

Taps.—It is desirable to have a tap where the hose joins the pump, so that the stream can be turned off at once by the man working the pump, otherwise much material will be wasted. On the extension-rod also a tap will be found useful.

The Agitator.—Any pump for using Paris green or mixtures containing lime should be fitted with a powerful agitator. Most of those in use in Tasmania are almost useless so far as Paris green is concerned. A good agitator should keep the Paris green continually stirred; if it were continually stirred one would not hear so frequently of the foliage being scorched, as is now the case. To see how rapidly Paris green sinks, it is only necessary to place a little in a bottle of water and shake it, when it will be seen that in less than five minutes practically the whole of the poison has settled to the bottom: naturally,

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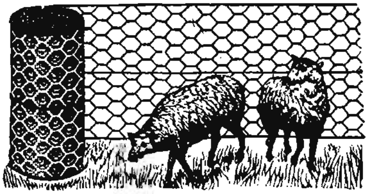

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the same takes place in a cask, with the result that some trees get an overdose and are badly scalded, whilst others are practically sprayed with water only. It therefore is often desirable to turn the nozzle and spray back into the pump, placing it especially into corners where the agitator has little effect.

Simplicity of Construction.—Other things being equal, a pump of simple construction is to be preferred, as where the pump is of intricate design many parts are apt to get out of order with the chemicals used, and with the careless handling to which nearly all pumps are subjected.

The Barrel.—Owing to the nature of the ground gone over, the pump is often violently jerked from side to side whilst travelling from tree to tree; it is always well, therefore, to have a pump that can be closed, so as to prevent the spray material being wasted gallons at a time.

After Use.—After the pump has been used, it should be washed out with water, as many of the chemicals used are highly corrosive in their action. The hose also should be washed out, especially if oils have been used, as many of these will dissolve rubber if in contact with it for a sufficiently long time.

Small Pumps.—Owing to the nature of the ground to be gone over, or to the smallness of its area, it is often compulsory or desirable to use a pump that can be carried and worked by one man. With these it is often not necessary to have special agitators, as the quantity used at a time (seldom more than 3 gallons) is so small that it is kept easily stirred; but a special fault of knapsack pumps is their liability to leak after being in use for some time, with the result that the operator has often a wet back; knapsacks also are often easily put out of order. There are some good pumps intended for use with kerosene buckets, &c.; but many of these are quite useless, except in the flower garden.

Powder Pumps.—The necessity for using these does not exist to any extent in Tasmania, as the grape-vine is so little grown. In any case, powder pumps are not suitable for trees, as it is difficult and often impossible to drive powder against wind, and to apply it to trees when damp with dew means that only a small area can be treated at a time.

Miscellaneous Notes.

A question frequently asked is whether two spray materials can be combined so as to destroy two pests with one application. Tests have been made with this object in view, but, owing to the antagonistic nature of many of the substances used, but few can be so mixed. One useful mixture which can be made, however, is the addition of Paris green or any other arsenical poison to the Bordeaux mixture. Soap should never be added to any mixture containing arsenic.

Many instances have occurred where spraying has injured trees; but in most instances this has been the fault of the orchardist himself, by using too strong a mixture or a badly-prepared one, or one used at the wrong time of the year. The sulphur, lime, and salt mixture, for instance, is an excellent winter spray, but used in the spring and summer it is liable to do serious injury to the foliage and fruit. The Bordeaux mixture can be used at a considerably greater strength in winter, and just before the buds are bursting, than after the fruit has set. Kerosene has been applied pure in the United

States and Australia with considerable benefit, but in some instances trees have been seriously injured and others even killed by it.

Theoretically, the best way to spray is in the form of a very fine mist, so that the trees are just coated, and very little of the material is wasted; but in practice, especially if the day is at all windy, it will be found to be almost or quite impossible to coat the trees in a reasonable time with a fine spray with certain materials. With kerosene emulsion, or other preparation where no grit is present, trees can be efficiently sprayed in the form of a very fine mist if a sufficiently powerful pump and lengthy hose are used. But with the Bordeaux mixture, or any other containing a large amount of grit, it will be found best to have a fairly coarse spray, as with a fine one the nozzles will be constantly getting blocked.

After the pumps and hoses have been used they should be thoroughly washed out, and the metal-work dried and oiled, as many of the chemicals used are very corrosive in action. Many of the materials used soon destroy rubber or leather valves.

A good plan when soldier bugs, earwigs, or wood lice are especially numerous in gardens is to make strong kerosene emulsion and spray the outer fences, especially where the palings join the rails. It is wonderful the numbers of insects which can be destroyed this way.

A point it might be desirable to emphasize is that when removing leaves or whole plants affected by insects or diseases it is not sufficient to throw these on to the manure heap and there leave them, but they should be destroyed by fire.

Many insects are very troublesome to the orchardist, but not sufficiently so to warrant the expenditure necessary in spraying with Paris green or other substances; in such cases hand-picking is often resorted to. Where the insects are small, however, very many of them can be obtained by jarring the trees or bushes into an inverted umbrella, when the insects will fall into it, and can be gathered up and destroyed. The best time to jar the trees, &c., is in the early morning before sunrise; after sunset, however, is almost equally as good. The insects at these times are very torpid, and will often remain without motion in the umbrella; during sunshiny days, however, many insects are much too active to be taken in this way.

It may be as well to point out here that the hawthorn is a very undesirable hedge-plant from the point of view of harbouring insects and fungi. It is attacked by the mussel and other scales, the cherry borer, pear slug, and fire blight, and serves as a harbour for the codlin grub; so that where these hedges are not looked after properly, or where single trees are growing wild, they should be destroyed, to prevent them harbouring these pests, and possibly others. Apple and other fruit trees, when neglected, are worse than useless, on account of the numerous pests they serve to maintain.

Trees can often be protected against the attacks of climbing insects by means of tarred paper funnels. These should be so fastened to the trees that the wide end of the funnel on its lower end projects for at least an inch away from the tree all round; the small end of the funnel being so closely fastened at its top that no insect can pass through. The insects, on crawling up the tree, come to the funnels, and are blocked, and in the case of biting insects the tar will prevent them from biting through the paper and so passing. The funnels will sometimes be found very useful for small trees in newly-cleared ground, where their buds are frequently attacked by small, night-moving weevils or by climbing cut-worms, &c.

Fumigating trees with hydro-cyanic acid gas generated under tents has been successful in innumerable cases in ridding trees of San José scale and other insects. This method of fighting insects was first adopted against the cottony-cushion scale (*Icerya purchasi*), and at the present time thousands of tents are in use throughout the United States, and many in other parts of the world, including Australia. The gas is also used in all the Australian States for preventing the introduction of fresh pests by means of nursery stocks and fruits.

For fumigating nursery stock, before sending same from the nursery, a small room is required, the principal requisite of which is that it shall be air-tight. This can easily be tested by burning a bundle of straw in it, when, if it is not properly made, smoke will be seen to escape from it.

The ingredients used to generate the gas are cyanide of potassium (an excessively dangerous poison), sulphuric acid, and water. The water and acid are mixed together in a crockery bowl, and the cyanide (which should be weighed out in small paper bags) placed in the liquid, when the gas is immediately generated. This gas is dangerous to breathe, and many accidents have resulted from its careless use. The cyanide should be 98 per cent.

Johnson states that the best results were obtained by the use of "25 grammes (a little less than 1 oz.) of cyanide, $1\frac{1}{4}$ oz. sulphuric acid, and $1\frac{1}{3}$ oz. water for every 100 cubic feet of space enclosed." He also says that "There is not the slightest danger of injuring nursery stock by a single, double, or even treble fumigation." It is to be noted, however, that tender plants, such as ferns, and some other pot-plants, are sometimes injured by the gas.

The late Professor Riley gives the following table of ingredients to be used according to the height of the trees:—

Height of Tree.	Diameter of Tree-top.	Water.	Sulphuric Acid.	Potassium Cyanide.
Feet.	Feet.	Fluid ozs.	Fluid ozs.	Ounces.
6	4	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
8	6	2	1	1
10	8	$4\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{4}$
12	10	8	4	4
12	14	16	8	8
14	10	10	5	5
14	14	19	$9\frac{1}{2}$	$9\frac{1}{2}$
16	12	16	8	8
16	16	29	$14\frac{1}{2}$	$14\frac{1}{2}$
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33

"All the tents were made of 8-oz. cotton duck, such as is used for making sails. With a little care any tent-maker can cut the sheets, so there is practically no waste in the material. They are cut and made into quadrants, and then put together. The centre in the large tents, for about 2 feet in diameter,

is double, as there is considerable strain upon the material. A ½-inch or ⅜-inch rope is hemmed in around the edges.

"The cost of the tent, of course, varies according to the size, and the cost of oiling must be added. All of our tents are thoroughly oiled by painting them with boiled linseed oil.

"The 7 x 10 x 4 box-tent is very convenient for trees varying in size from 4 to 8 feet.

"We used a single pole in our work for tenting and untenting a tree. The pole is an 18-feet sapling."—(Johnson.)

After oiling the tents care should be taken that they are carefully aired and dried, otherwise not only are they more liable to gather dirt, but they are subject to spontaneous combustion when stowed away.

After the tents are adjusted over the trees, and the gas generated, they require to be left in position for one hour. The gas by that time will have killed all the scale insects (and in the case of egg-laying species the eggs also), except a few protected by overlapping scales when the trees are very heavily infested. Injury to delicate foliage has sometimes resulted from the use of the gas on hot days; but when used during the winter, or in the cool of the day, or at night time, it appears to be absolutely safe.

No record has been published (at least so far as the writer is aware) of the effects of fumigation on codlin grubs in the bandages and rough bark of fruit trees. If it is possible to destroy these (and one would imagine that a gas sufficiently powerful to destroy scale insects and their eggs would also destroy codlin grubs), then fumigation is a remedy that should commend itself to every Tasmanian orchardist who is troubled by both these pests. This, however, is a matter which can only be decided by experiment.

THE GROWTH OF AN APPLE BUD IN ITS RELATION TO SPRAYING.

If we examine an apple tree, except during the dormant season, when the various processes going on are concealed from us, we can see that continuous growth is taking place, and this growth naturally has an important bearing on the times at which spraying for various pests and diseases should be done. Here it is endeavoured to exemplify this by a series of figures, showing one bud and a young apple during their earlier stages.

Fig. 1.—In this stage the bud is dormant, as it is during August and the other winter months. It is then almost cone-shaped, with closely overlapping scales or plates, so tight that no liquid can penetrate between them, and no thicker than its supporting spur. If it is intended to do any spraying with red oil or crude petroleum, this is the time at which it should be done, as the oils cannot penetrate between these plates to injure the buds, whilst the woolly aphis, mites and scale insects are more easily got at than at any other period.

Fig. 2.—The same bud (during the middle of September) considerably swollen and beginning to burst; some of the older scales or plates have fallen off through the inside pressure. It is dangerous to spray with any oil at this time as there are so many openings into the buds, and the young leaves are so covered with down, that the buds act as so many small sponges to suck up the spray, so consequently, as they

are very tender, are readily injured by the oil, and in fact many trees have been seriously injured by spraying with red oil at this time.

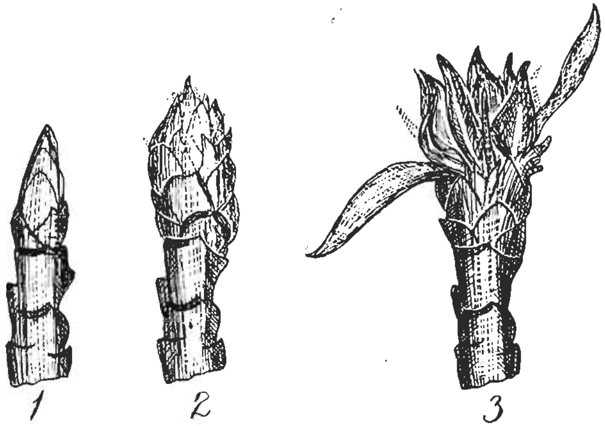
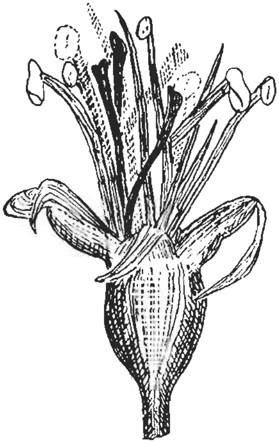


Fig. 3.—The bud a few days later, showing how the swelling has proceeded; the flower buds can be first distinctly seen at this stage. It is also usually about this time that the young *Bryobia*, or red mites (often called red spiders), first make their appearance, and 30 or 40 may often be counted on a

young leaf. The attacked leaves afterwards assume the greyish speckled appearance due to attacks of these little pests. Spraying with an oil emulsion at this time is certain to result in injury.

Fig. 4.—The bud opened, with the blossoms red and ready to burst. This is the stage that experience in Tasmania and Victoria has proved is the best in which to spray with the Bordeaux mixture for black spot.

Fig. 5.—The young apple, just after the petals have fallen, showing how Paris green or other spray can be lodged in the calyx cup. This is the stage now almost universally recommended in which to use the first spray against the codlin moth. Spraying at this time with a properly-made arsenical poison



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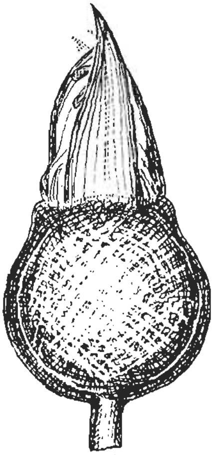

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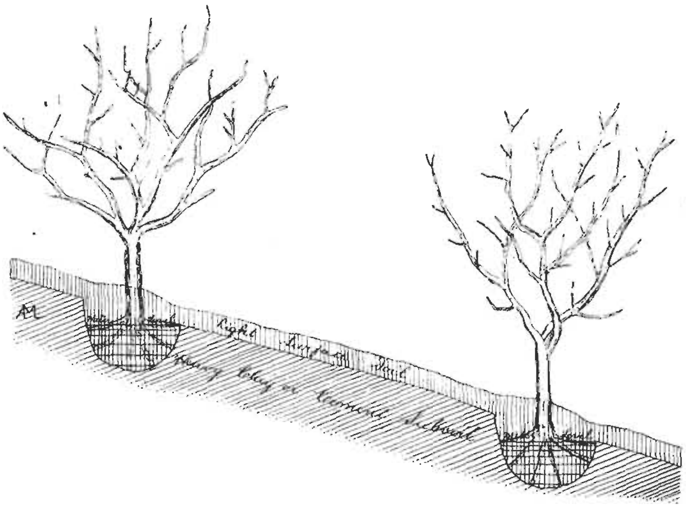
is certain to destroy a very large proportion of the young grubs that otherwise would have entered at the eye.

Fig. 6.—The same apple a little after, showing how the calyx lobes have closed over, and rendering it impossible for any poison to be lodged in the eye; or, if any poison has already been lodged there, how it cannot be washed out by rain.

POT-HOLES IN SLOPING ORCHARDS.

The very natural opinion is often held that on sloping ground or on the summits of small hills there is no necessity to drain orchards. In many instances, no doubt, there is less necessity to drain such orchards than those that are fairly flat, but there are probably no orchards that are not the better for some kind of drainage, and especially when there is a clay or cement subsoil within a foot or two of the surface. A common practice in sloping orchards is to dig pot-holes, sometimes as much as 3 feet into the subsoil; these are then partially filled in with lighter soil and manure, the young trees planted, and then the holes completely filled in. In ordinary years no harm results, and when the subsoil is at all loose no harm may ever follow. In wet seasons, however, these pot-holes simply become small reservoirs of water, for which there is no natural getaway. The result is often that the roots get drowned. A sketch is here given to illustrate this point. The rain when it falls soaks through the light surface soil till it comes to the heavier sub-

soil; this soon becomes charged with water; the overplus does not pass through it, but soaks along the top. If then pot-holes have been made for the trees, these soon become filled with water, and in *continuous* wet weather stay filled; the soil becomes sour, the rootlets, which in spring should be numerous and healthy, get clogged and rot off, then the branches die at the tips, and many of the trees die outright, often just after flowering. On examining the roots these are often seen to be covered with nodular fungi, or with the mycelial threads (looking like frayed cotton) of other fungi. They often, in fact, have the sourish, sickly smell of decaying puff-balls. These fungi seldom attack perfectly healthy trees, but once a tree becomes sick and is attacked by them the fungi will often prevent its recovery. The soil at the roots often appears as a kind of stiff, wet clay



Pot-holes in Sloping Orchards.

like putty, smells quite sour, and not infrequently turns to a dirty green colour. All these are typical results of the want of drainage. In some years thousands of apple and apricot trees die in Tasmania from this cause.

CROSS-FERTILISATION.

It is well known that *cross-fertilisation* is highly necessary for many plants, and that without it many will not produce seed. Many queer contrivances have been elaborated by plants for this purpose, but on these there is no need to go into here.

The fact, however, of this necessity has a strict practical bearing on Tasmanian orchards. On looking at a large block of Scarlet Nonpareils in an orchard near New Norfolk, the writer was greatly struck by the fact that these trees, although large and healthy, bore very light crops indeed, except where the rows adjoined other varieties. These trees were then 18 years of age, and had never borne even medium crops, *except*

where they adjoined rows of other varieties. On one side were New York Pippins, and on the other Sturmer Pippins, and the three rows on each side next these varieties bore as they should have done. A more remarkable fact, however, has still to be noted. In the middle of the block a Sturmer Pippin had been planted by mistake, and it was noticed every year the Scarlet Nonpareils in the vicinity of this tree always bore heavy crops. In the same orchard was another large block of Scarlet Nonpareils, which also had borne very poorly in the middle, and as it ought where it adjoined some New York Pippins.

At the Huon, also, other blocks of apple trees were seen that had never borne well, but these were French Crabs. At one orchard at Ranelagh were 20 rows of large French Crabs 15 years of age. The rows that adjoined some Sturmer Pippins bore well, but the inside rows never bore well. A block of French Crabs growing in a little gully at Cradoc also never bore satisfactory crops, although the trees were very large and nearly 20 years of age; these were growing by themselves, where they could not be cross-fertilised.

Several large blocks of pears in Tasmania have never borne well, but the necessity for cross-fertilisation with this fruit is better known.

The remedy is very simple. Where the trees are in large blocks, and have been bearing poorly for years, cut every fifth row back and graft on some other variety. In setting out new orchards care should be taken that not more than four rows of a kind are planted out together.

Of course, with many varieties of both apples and pears the necessity for cross-fertilisation is not so pronounced, but there are probably few varieties of fruit that are not better for it.

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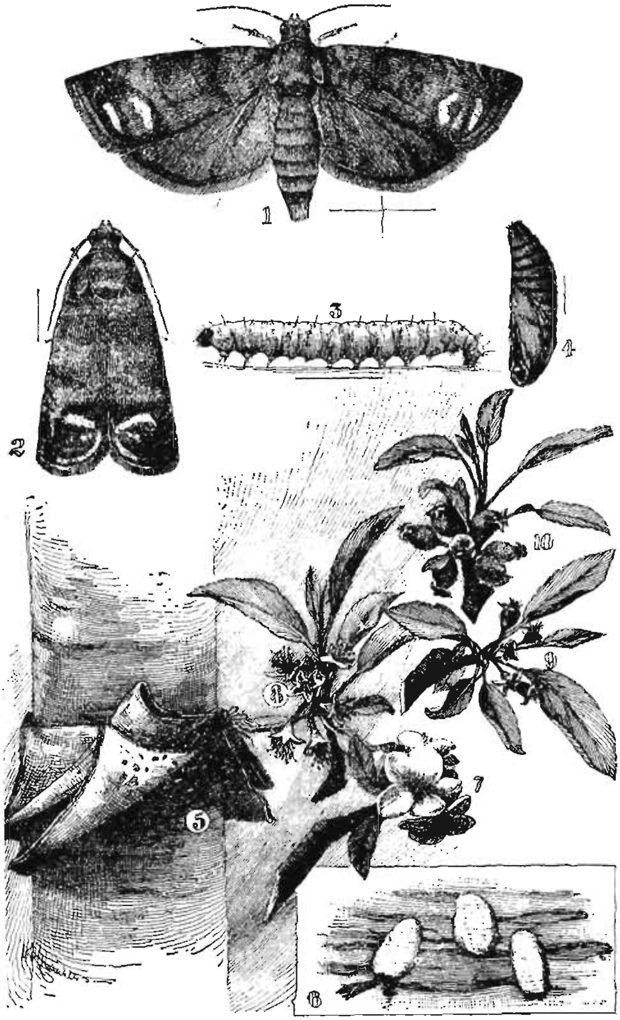

THE CODLIN MOTH.

oth; 2, Characteristic attitude of Moth: 3, Larva: 4, Pupa: 5, Bandage raised, showing Cocoons: 6, Cocoons and Pupa-Case; 7, Blossom too early for Spraying; 8, Correct Stage for Spraying; 9 and 10, Too late to commence Spraying.

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